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PHYSICS ABSTRACTS

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SECTION A OF SCIENCE ABSTRACTS

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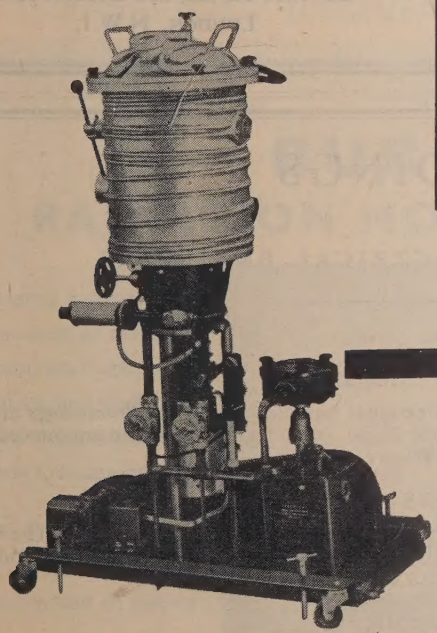

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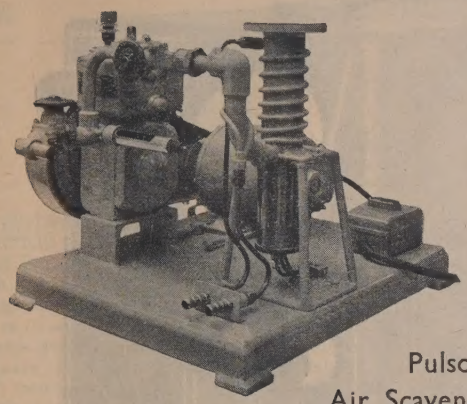

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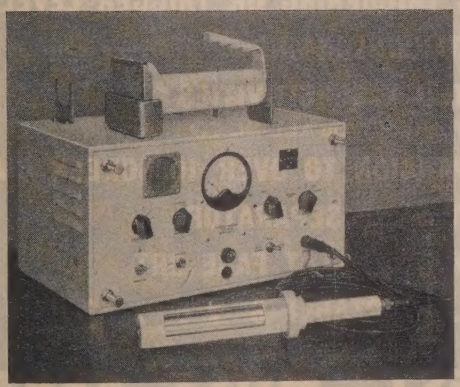

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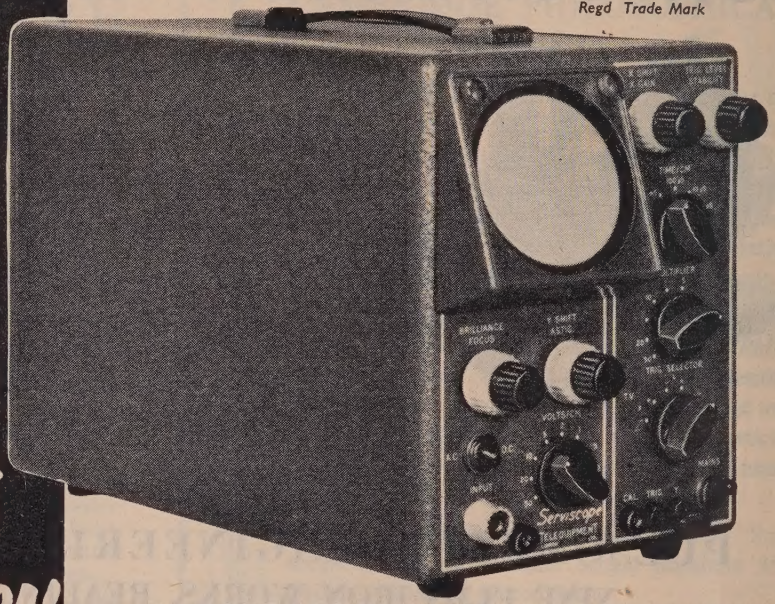

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PHYSICS ABSTRACTS

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MATHEMATICS

517.5

1407. METHOD OF INVERSION OF THE PRODUCT OF COMPOSITION OF HISTOGRAPHIC FUNCTIONS. M.Tournarie.
C.R. Acad. Sci. (Paris), Vol. 245, No. 16, 1301-3 (Oct. 14, 1957). In French.

An extension of a previous note (Abstr. 1830/1956). The problem is to solve a certain type of integral equation. The usual approximate method leads to calculations whose number N depends on the square of the number n of intervals taken. The method now indicated, making use of a certain algebra over the elements of a ring, reduces the amount of calculation in such a way that N is proportional to n and not n^2. L.S.Goddard

517.5

1408. COEFFICIENTS FOR "DECOMPOSITION" OF FUNCTIONS INTO LAGUERRE-FUNCTION SERIES.
J.W.Head and G.M Oulton.
Proc. Instn Elect. Engrs, Monogr. 252R, publ. Aug., 1957 (Vol. 105C, 55-6).

Republication of the monograph abstracted in Abstr. 6804(1957).

517.564.4

1409. ASYMPTOTIC FORMULAE FOR GENERALIZED [ASSOCIATED] LEGENDRE FUNCTIONS AND GEGENBAUER FUNCTIONS. R.M.Muradyan.
Dokl. Akad. Nauk SSSR, Vol. 115, No. 5, 887-90 (1957). In Russian.

Writing the solution to the differential equation obeyed by the associated Legendre functions $P_l^m(\cos\theta)$ as $u = (\theta/\sin\theta)^{1/2} f(\theta)$ and neglecting terms of order $1/l^2$ and m^2/l^2, $f(\theta)$ is found to satisfy Bessel's equation, which enables asymptotic formulae for $l \gg m$ to be easily obtained for $P_l^m(\cos\theta)$, $Q_l^m(\cos\theta)$ and analogously for $P_l^m(\cosh\theta)$ and $Q_l^m(\cosh\theta)$. These are valid over a wide range of θ, particularly for θ close to zero. For $m = \pm\frac{1}{2}$ they are exact. Asymptotic formulae for large λ are given for $P_{-1/2+i\lambda}(\cos\theta)$, $Q_{-1/2+i\lambda}(\cos\theta)$, $P_{-1/2+i\lambda}(\cosh\theta)$ and $Q_{-1/2+i\lambda}(\cosh\theta)$. Relating the Gegenbauer functions $C_l^\nu(\cos\theta)$ to $P^{1/2-\nu}_{l+\nu-1/2}(\cos\theta)$, asymptotic formulae are given for $C_l^\nu(\cos\theta)$ for $l \gg \nu$, which are exact for $\nu = 1$. By $l = 10$, numerical calculations using the formulae show good agreement. Formulae for the hypergeometric functions of Gauss $_2F_1[\alpha - \lambda, \beta + \lambda, (\alpha + \beta + 1)/2, \sin^2(\theta/2)]$ and Whittaker $M_{\lambda,\mu}(z)$ for large λ are also quoted. M.J.Kearsley

517.948 : 536.33

1410. ON WIENER–HOPF EQUATIONS. K.M.Case.
Ann. Phys. (New York), Vol. 2, No. 4, 384-405 (Oct., 1957).

A method due to Ambarzumian and Chandrasekhar is generalized to apply to a large class of integral equations of the Wiener–Hopf type. There seem to be two main advantages of the method: (a) many properties of solutions can be obtained in an elementary way; (b) the Wierner–Hopf factorization can be replaced by a non-linear equation which is often particularly suited for numerical evaluation. A.

518.5 : 621.317.79

1411. AN ELECTRICAL RESISTANCE ANALOGUE WITH A GRADED MESH. P.J.Palmer and S.C.Redshaw.
J. sci. Instrum., Vol. 34, No. 10, 407-9 (Oct., 1957).

Details are given for the design and construction of an electrical resistance analogue having a graded mesh. The network is economical to build and, since it consists of eight separate units, it can be assembled in a variety of ways. Thus, for any particular problem in fluid mechanics or elasticity, a suitable and efficient analogue is readily available and it has been successfully used to solve a wide range of problems in these fields. A.

518.5 : 539.18

1412. DYNAMIC PROGRAMMING AND THE VARIATIONAL SOLUTION OF THE THOMAS–FERMI EQUATION. B.Bellman.
J. Phys. Soc. Japan, Vol. 12, No. 9, 1049 (Sept., 1957).

ASTRONOMY . ASTROPHYSICS

523.12 : 538.3

1413. COSMICAL ELECTRODYNAMICS. J.H.Piddington.
Proc. Inst. Radio Engrs, Vol. 46, No. 1, 349-55 (Jan., 1958).

The spectacular results of radioastronomy have increased interest in the broader field of electromagnetic phenomena in cosmical physics. This subject is introduced here by a discussion of the various possible types of disturbance which may propagate in a magneto-ionic medium. The results are then applied in some regions of interest, particularly those from which nonthermal radio emission takes place. In the solar atmosphere many otherwise mysterious phenomena are explained as electromagnetic effects: the heating of the corona to 10^6 °K, flares, the violent motion of the gases and emission of radio waves, as well as X-rays and the corpuscles which cause magnetic storms. Interstellar space, the interior of a mysterious nebula and radio source (the Crab nebula), and interplanetary space provide more examples of electromagnetic phenomena. One of the most fundamental problems concerns the origin of cosmic rays, now believed to result from electromagnetic processes. Evidence is provided of an even more fundamental process: the creation of magnetic field on such an enormous scale that nuclear energy sources are indicated. A.

523.164

1414. THE DISCOVERY AND IDENTIFICATION BY KARL GUTHE JANSKY OF ELECTROMAGNETIC RADIATION OF EXTRA-TERRESTRIAL ORIGIN IN THE RADIO SPECTRUM.
C.M.Jansky, Jr.
Proc. Inst. Radio Engrs, Vol. 46, No. 1, 13-15 (Jan., 1958).

523.164

1415. EARLY RADIO ASTRONOMY AT WHEATON, ILLINOIS.
G.Reber.
Proc. Inst. Radio Engrs, Vol. 46, No. 1, 15-22 (Jan., 1958).

A history is given of radioastronomy experiments conducted by the author from 1936 through 1947. A description of the parabolic reflector and equipment design is presented along with reasons for the choice of successive operating frequencies of 3300, 910, 160 and 480 Mc/s. The results are reviewed in light of more recent knowledge. A.

523.164 : 621.396.677

1416. A HIGH RESOLUTION RADIO TELESCOPE FOR USE AT 3.5 M. B.Y.Mills, A.G.Little, K.V.Sheridan and O.B.Slee.
Proc. Inst. Radio Engrs, Vol. 46, No. 1, 67-84 (Jan., 1958).

A pencil-beam radio-telescope of the cross type is described; it has a beamwidth of 49 min of arc and a sensitivity which approaches, under ideal conditions, 2×10^{-26} W.m^{-2}.(c/s)$^{-1}$, that is, about 1/10 000 the flux density of the strongest radio-source. To speed the collection of information the beam may be scanned, presenting information on five separate declinations quasi-simultaneously. Although it is intended primarily as a survey instrument, strong radio-sources may be located with high accuracy; the probable errors in the measured positions of the stronger identified sources average less than a 1 ft arc. Methods of calibrating the flux density and temperature scales are described and some examples are given of the use of the radio-telescope. The theory of operation and some of the design factors are discussed and it is concluded that, for a given size of aerial and the best s.n.r. on a typical radio-source, the wavelength is rather well defined. This optimum generally lies in the range 2 m to 4 m, depending on details of the receiver and aerial design; other factors, however, play an important part in the choice of wavelength. A.

523.164

1417. RADIO INTERFEROMETRY OF DISCRETE SOURCES. R.N.Bracewell.
Proc. Inst. Radio Engrs, Vol. 46, No. 1, 97-105 (Jan., 1958).

Salient features of the theory and practice of radio interferometry are presented with special attention to assumptions and to the specifically two-dimensional aspects of the subject. The measurable quantity on an interferometer record is defined as complex visibility by generalization from an analogous quantity in optical interferometry. Subject to conditions on aerial size and symmetry, the observed complex visibility is equal to the normalized two-dimensional Fourier transform of the source distribution, with respect to certain variables S_x and S_y which are defined. This transform is in turn identically equal to the complex degree of coherence Γ between the field phasors at the points occupied by the interferometer elements. The correlation between the instantaneous fields, and that between the instantaneous intensities are less general parameters which are, however, deducible from Γ. A theorem is proved according to which only certain discrete stations on a rectangular lattice need be occupied for full determination of a discrete source distribution. Procedures in interferometry are discussed in the light of this result and an optimum procedure is deduced. Current practice is considered over-conservative, e.g., independent data in the case of the sun are obtainable only at station spacings of about 100 wavelengths on the ground, a fact which has not hitherto been taken into account. A.

523.164

1418. RESTORATION IN THE PRESENCE OF ERRORS. R.N.Bracewell.
Proc. Inst. Radio Engrs, Vol. 46, No. 1, 106-11 (Jan., 1958).

The observed aerial temperature due to a celestial source distribution differs from the true distribution in being smoother; various methods are known for operating on the observed distribution to gain better agreement with the true distribution. Current practice includes restoration by successive substitutions, by the chord construction, etc., but also shows a trend towards complete omission of any restoration, which is, no doubt, partly due to awareness that the true distribution is not fully determined by the observations. The isolation of a principal solution has, however, removed uncertainty as to the significance of nonuniqueness. The remaining question as to the degree of restoration which can be tolerated is solved here in terms of statistical properties of the errors. The solution shows that any proposed method of restoration must include mention of the character of the true distribution and of the errors; otherwise cases could be constructed where the proposed method led to deterioration. In the simplest case of independent random errors and a poorly resolved distribution, the r.m.s. level of the errors relative to the observed temperature is the relevant parameter e.g., with a random error level as great at 15%, agreement with the true distribution improves up to the third stage of restoration by successive substitutions or on application of the chord construction. A.

523.164 : 621.317.794

1419. A METHOD OF CALIBRATING CENTIMETRIC RADIOMETERS USING A STANDARD NOISE SOURCE. J.S.Hey and V.A.Hughes.
Proc. Inst. Radio Engrs, Vol. 46, No. 1, 119-21 (Jan., 1958).

In order to compare radioastronomical measurements of power flux observed on different occasions at different wavelengths, special attention must be paid to methods of calibration. A method is described which is suitable for a centimetric radiometer measuring aerial temperature over a range of 0 to 1000°K or more with an accuracy of about 1°K. The power received by the radiometer is compared with that from a CV1881 argon discharge tube fed through a precision attenuator. An additional fixed amount of power is added to that of the radiometer to ensure that the effective temperature is above that of the room. The intensity of solar radiation at $\lambda = 10.5$ cm was measured by this method during the eclipse of June 30, 1954. The scale of the chart recording the radiometer output was effectively increased by adjusting the attenuator in steps each time maximum deflection was attained corresponding to about 20°K change of aerial temperature. Finally, to measure the brightness temperature of the uneclipsed sun, the received power from the sun was compared with that from a known external noise source consisting of a horn radiator fed by a CV1881 argon discharge tube. A.

523.164

1420. RADIO ASTRONOMY POLARIZATION MEASUREMENTS. M.H.Cohen.
Proc. Inst. Radio Engrs, Vol. 46, No. 1, 172-83 (Jan., 1958).

Various polarization measuring schemes are discussed in terms of the Stokes parameters. The methods are separated into three groups according to the number of components isolated by the aerial system. The dispersion resulting from the frequency dependence of the Faraday effect is considered, and the interpretation of polarization data in terms of these effects is discussed. Some results are that one polarization determination will allow limits to be placed on the axial ratio and polarization percentage at the source, and on the ray path integral of longitudinal magnetic field times electron density. A graphical presentation of Hatanaka's dispersion theory permits this to be done very quickly. With suitable assumptions, measurements at two frequencies or with two bandwidths will fix the three quantities. Radioastronomy polarization observations are surveyed. The ionosphere, solar corona and Crab Nebula are considered briefly in the light of possible Faraday effects. Mayer, McCullough and Sloanaker's 3.15 cm observations on the Crab Nebula and the optical results are used to analyse lower frequency attempts to find polarized radiation from this object. A.

523.164 : 621.396.946

1421. THE CORNELL RADIO POLARIMETER. M.H.Cohen.
Proc. Inst. Radio Engrs, Vol. 46, No. 1, 183-90 (Jan., 1958).

The Cornell polarimeter operates on 201.5 Mc/s with a bandwidth of about 10 kc/s. This bandwidth is an order of magnitude smaller than previously used. The instrument is basically similar to the interference polarimeter built by Little and Payne-Scott, although it does not operate on an interference basis. The two circular components and the phase and correlation are measured. Ratios of the measured quantities are used graphically to find the polarization percentage and axial ratio. The system is calibrated on a relative basis by transmitting noise from a distant vertical dipole. The errors introduced by inaccuracies in the aerials are discussed; it is shown that the measured inaccuracies might give errors on the order of ±0.05 in axial ratio and polarization fraction. The observed polarizations are similar to what has been reported by other observers, so qualitively there is no gross "bandwidth effect". Mixed and variable polarizations have been seen. An example of a mixed polarization record is shown. A.

523.164 : 621.396.946

1422. A TIME-SHARING POLARIMETER AT 200 Mc. S.Suzuki and A.Tsuchiya.
Proc. Inst. Radio Engrs, Vol. 46, No. 1, 190-4 (Jan., 1958).

This instrument observes a set of two circular and four linear components of polarization in 1/200 of a second, with 1/1200 of a second interval for each component, so that practically a simultaneous observation of rapidly varying phenomenon such as a solar burst is made possible. Some details on the electronic switching, the square-law detector, and the method of calibration and checking are discussed. A.

523.164 : 621.396.946

1423. A POLARIMETER IN THE MICROWAVE REGION. K.Akabane.
Proc. Inst. Radio Engrs, Vol. 46, No. 1, 194-7 (Jan., 1958).

A polarimeter at the frequency of 9000 Mc/s for the observation of the solar-radio emission is described. The method of phase modulation at the r.f. circuit is applied to detect the polarized components in the incident waves. The amplitude modulation by ferrite switching also is used to get higher accuracy for the observation. The Stokes parameters (I,Q,U, and V) in a partially-incident wave can be obtained directly. The minimum detectable intensities of these parameters are 3 for I + Q/2 and V, and 6 for Q and U respectively in the units of 10^{-22} m.k.s. An example of the observation shows the complex polarization of a solar-radio burst at this frequency. A.

523.164

1424. ABSORPTION TECHNIQUES AS A TOOL FOR 21 cm RESEARCH. A.E.Lilley and E.F.McClain.
Proc. Inst. Radio Engrs, Vol. 46, No. 1, 221-9 (Jan., 1958).

Hyperfine transitions between the F = 0 and F = 1 levels of interstellar hydrogen gas have been observed to produce absorption lines in the spectra of radio-stars. Elementary relations are developed which describe the action of an L band radiometer connected to an aerial, if the aerial is viewing an assembly of gas which is illuminated by a radio-star. The consequences of the absorption line studies are reviewed. They include: high resolution studies of the interstellar gas, the structure and physical state of interstellar H I regions, minimum distances to radio-stars, and experiments of interest in cosmology. A.

523.164

1425. A PHASE TRACKING INTERFEROMETER. H.Penfield.
Proc. Inst. Radio Engrs, Vol. 46, No. 1, 321-5 (Jan., 1958).

A series of radio-telescope receivers has been developed to operate in a switched interferometer system of the type described by Ryle. The new features of the equipment include automatic tracking and recording of the phase difference of a coherent signal at the two receiver input terminals. Chart recorded outputs of total power, signal power, and signal phase are provided. The receiver utilizes dual low-noise r.f. amplifiers with a high degree of frequency selectivity. Fixed delay lines are available in both receiver channels to allow operation on the higher order lobes of the interference pattern. Front panel controls include a precision gain control, a receiver bandwidth selector, manual and automatic phase tracking controls, and signal power and total power integration time constant switches. Background and signal noise sources are provided for direct calibration of the receiver. Three of these receivers are currently in operation on frequencies of 53 Mc/s, 108 Mc/s and 470 Mc/s in a two-antenna drift interferometer at the National Bureau of Standards Laboratory in Boulder, Colo. A.

523.164 : 525.72

1426. RADIO ASTRONOMY MEASUREMENTS AT V.H.F. AND MICROWAVES. J.Aarons, W.R.Barron and J.P.Castelli.
Proc. Inst. Radio Engrs, Vol. 46, No. 1, 325-33 (Jan., 1958).

Radioastronomy measurements of atmospheric absorption, refraction and scintillation, taken during the summer of 1956, and the spring of 1957, were made at 3.2 cm and 8.7 mm with the sun as the source, and at 218 Mc/s with solar energy and radiation from Cassiopeia A. Large tropospheric scintillations at angles below 3^0 made elevation accuracy difficult in the 8.7 mm and 3.2 cm bands. Refraction at 218 Mc/s was greater than at the microwave wavelengths. Scintillations at 218 Mc/s were present during periods of auroral activity. The information obtained has been useful in assessing radar angle-of-elevation accuracy and demonstrates the use of the sun and other celestial bodies as radiation sources for aerial pattern measurements. A.

523.164

1427. CERTAIN CHARACTERISTICS OF RADIO EMISSION BY COSMIC OBJECTS. A.D.Kuz'min.
Radiotekhnika, Vol. 12, No. 1, 12-21 (1957). In Russian.

A general introduction to radio astronomy, explaining the basic concepts, quoting formulae for the energy pickup of the aerial system and the equivalent noise temperature of the aerial and tabulating radio emission intensity of the sun (for periods of maximum and minimum spot occurrence) and of discrete sources from our Galaxy and also from extra-galactic space, measured by Russian observers. No information on receiver installations is given. An extensive international bibliography is appended. A.Landman

523.164.3

1428. MEASUREMENTS OF PLANETARY RADIATION AT CENTIMETER WAVELENGTHS.
C.H.Mayer, T.P.McCullough and R.M.Sloanaker.
Proc. Inst. Radio Engrs, Vol. 46, No. 1, 260-6 (Jan., 1958).

Radiation from the planets, Venus, Mars and Jupiter was measured at a wavelength of 3.15 cm using a 50 ft reflector and a narrow-band radiometer. The apparent blackbody temperatures for Mars and Jupiter derived from the radio measurements agree reasonably well with the results of infrared radiometric measurements. For the case of Venus, the apparent blackbody temperature derived from the 3.15 cm measurements is about a factor of two higher than the value derived from the infrared measurements. A measurement of the radiation from Venus at 9.4 cm wavelength was made using the same aerial. The apparent blackbody temperature derived from this measurement agreed well with the value derived from the 3.15 cm measurement, but the accuracy of the 9.4 cm result was low because of the small flux density of radiation and the small number of observations. A.

523.164.3

1429. PLANETARY AND SOLAR RADIO EMISSION AT 11 METERS WAVELENGTH. J.D.Kraus.
Proc. Inst. Radio Engrs, Vol. 46, No. 1, 266-74 (Jan., 1958).

Observations are described of radio emissions from the Sun, Jupiter and Venus during 1956 and early 1957 at a wavelength of 11 m. Records are presented of solar 11 m radiation at the time of a large (importance 3) flare on August 31, 1956 and during other periods of solar activity. The effect of scintillation on records of radio-stars also is illustrated. A number of records of impulsive radiation from Jupiter at both slow and fast recorder speeds is shown. The radiation is of a bursty or intermittent nature which can be classified into two main types: one which may persist for several seconds and produces a rumbling sound in the loudspeaker and another which is of very short duration (10 milliseconds or less) and produces a cracking or clicking sound. Many of the short pulses consist of distinct pairs or triplets which fall into two main groups, one having pulse separations of about one-quarter second and the other, pulse separations of about one tenth this value. An echo mechanism to explain the multiple pulses is postulated and observed trends in pulse separation compared to those expected with such a mechanism. The stronger Jupiter pulses indicate a peak radiated radio power at the source of the order of 10 kilowatts per c/s bandwidth. Observations of 11 m radio emission from Venus are described and one record is presented for which the probability is only about one in a hundred thousand that it is due to a random process instead of Venusian radiation. A.

523.164.3

1430. RADIO EMISSION FROM COMET 1956 h ON 600 Mc. R.Coutrez, J.Hunaerts and A.Koeckelenbergh.
Proc. Inst. Radio Engrs, Vol. 46, No. 1, 274-9 (Jan., 1958).

Radiation from Comet 1956 h was observed on 600 Mc/s at perihelion. An attempt to identify this emission, which presented a rather stable character, was made. It appears that this radiation may arise from transitions between fine structure components resulting from Λ-type doubling of the level J = 3/2 of the $^2\Pi_{3/2}$ state of CH molecule. The observed flux density leads to a number of molecules of the order of 10^{30}-10^{31}, which is compatible with admitted numbers in cometary atmospheres. A.

523.164.3

1431. LUNAR THERMAL RADIATION AT 35 kMc. J.E.Gibson.
Proc. Inst. Radio Engrs, Vol. 46, No. 1, 280-6 (Jan., 1958).

Measurements of the thermal radiation of the moon were made at a frequency near 35 kMc/s to investigate further the variation of the radio-wavelength brightness temperature with lunar phase first observed by Piddington and Minnett at 24 kMc/s. The subject measurements, when referred to the equivalent blackbody temperature for the centre of the lunar disc, show a complex rather than sinusoidal variation with phase, varying between 225^0 and 145^0 K. The directivity of the aerial (about 0.2^0 of arc between half-power points) was sufficient to indicate the lunar equatorial (east-west) brightness distribution; this was found to vary in the expected manner and was in agreement with the form of the central brightness variation during a lunation. Observations of two total lunar eclipses showed that no measurable change in lunar radiation occurs during the few hours of an eclipse. Comparison of these results with calculations by Jaeger suggests the lunar surface is composed of a layer of fine dust of very low thermal conductivity, the average depth of which is estimated as one inch or more. A.

523.164.32 : 523.78 : 551.510.535

1432. THE SWEDISH RADIOSCIENTIFIC SOLAR ECLIPSE EXPEDITION TO ITALY, 1952. PRELIMINARY REPORT.
S.I.Svensson, G.Hellgren and O.Perers.
Acta polytech., No. 212 (1957) [Elect. Engng Ser. Vol. 7, No. 6] 30 pp. = Chalmers Tekn. Högsk. Handl., No. 181 (1956).

Pt I of the report describes the ionospheric part of the expedition. It gives general information of the sweep-recording equipment. It also presents the E-, F1- and F2-observations made. The experimental reduction in critical frequency is found to be greater than theoretically predicted. The discrepancy is discussed. Pt II reports the solar noise measurements on 2 metre wavelength. General information about equipment and aerial system is given. Total intensity and the amount of circular polarization of the solar radiation were measured. A short discussion of the observational results is given. A.

523.164.32

1433. DISCUSSION OF 10.7 cm SOLAR RADIO FLUX MEASUREMENTS AND AN ESTIMATION OF THE ACCURACY OF OBSERVATIONS. W.J.Medd and A.E.Covington.
Proc. Inst. Radio Engrs, Vol. 46, No. 1, 112-18 (Jan., 1958).

The accuracy of the daily 10.7 cm solar flux measurements taken at the National Research Council, Ottawa, is investigated. The various system parameters are examined and an auxiliary experiment, using a horn aerial, is described. These studies lead to a revision of the early values of the solar flux and require the use of conversion factors to some of the published data. It is estimated that the relative error between observations separated by intervals of months may be ±10% during 1947 through 1949, and ±3% during subsequent years. The systematic error in 1952-1953 was estimated at ±7%. A.

523.164.32

1434. MEASUREMENTS OF SOLAR RADIATION AND ATMOSPHERIC ATTENUATION AT 4.3 MILLIMETERS WAVELENGTH.
R.J.Coates.
Proc. Inst. Radio Engrs, Vol. 46, No. 1, 122-6 (Jan., 1958).

The sun was scanned with a radio-telescope consisting of a 10 ft precision paraboloid aerial (6.7 minute beamwidth) and a Dicke-type radiometer. Atmospheric attenuations were determined from the change in received solar radiation with changing elevation of the sun and from direct measurements of the thermal radiation from the atmosphere. The measured attenuations at the zenith for clear skies were between 1.6 and 2.2 dB. At 4.3 mm wavelength, the sun (when it is free of sunspots) appears to be a uniform disk nearly 1% larger than its optical size. From a large number of measurements over a period of 6 months, the solar brightness temperature was found to be 7000° K with an uncertainty of about 10%. Sunspot regions are slightly brighter than the quiet areas; the largest observed enhancement is 2%. A.

523.164.32

1435. SCANNING THE SUN WITH A HIGHLY DIRECTIONAL ARRAY. W.N.Christiansen and D.S.Mathewson.
Proc. Inst. Radio Engrs, Vol. 46, No. 1, 127-31 (Jan., 1958).

A survey is given of the very highly directive equipment and methods which have been devised to obtain details of the distribution of radio emission over the solar disk. A new instrument is described; it operates on a wavelength of 21 cm and gives, for the first time, radio pictures of the sun. This radio heliograph combines principles of the multielement interferometer and the Mills Cross. It consists of 64 parabolic aerials, 19 ft in diameter, arranged along two lines, each 1240 ft in length, in form of a cross. Multiple pencil beams about 3' arc wide are produced by the system, by means of these, the sun is scanned television-wise. The radio-heliograph is being used to produce daily pictures of the sun. A.

523.164.32

1436. THE RADIO SPECTRUM OF SOLAR ACTIVITY.
A.Maxwell, G.Swarup and A.R.Thompson.
Proc. Inst. Radio Engrs, Vol. 46, No. 1, 142-8 (Jan., 1958).

Observations of the solar radio spectrum have been made at the Harvard Radio Astronomy Station, Fort Davis, Texas, daily from sunrise to sunset since September, 1956. The equipment comprises three separate receivers covering the total range 100-580 Mc/s, and these are attached to a 28-foot-diameter paraboloid aerial. The outputs of the receivers are displayed on intensity modulated, high-resolution cathode-ray tubes, and these are photographed by a continuous motion camera. Over-all, the system is approximately ten times more sensitive than any sweep frequency equipments used previously for solar observations. Examples of the records showing the four main types of radiation from active areas on the sun are given, and brief comments are made on the existing theories to account for them. A.

523.164.32 : 523.75

1437. STUDIES AT THE McMATH-HULBERT OBSERVATORY OF RADIO FREQUENCY RADIATION AT THE TIME OF SOLAR FLARES. H.W.Dodson.
Proc. Inst. Radio Engrs, Vol. 46, No. 1, 149-59 (Jan., 1958).

The complex flare phenomenon is described in terms of its photographic aspect on Hα spectroheliograms, associated prominence activity, terrestrial effects, and the general pattern of radio-frequency emission. Flare-associated events at 2800 and 200 Mc/s are reviewed, and the association between flares and the onset of 200 Mc/s noise storms is discussed. Records of 2800 and 200 Mc/s radiation at the time of 277 flares are compared. Flare-events at frequencies less than 200 Mc/s are considered, and a study of 496 flares at 80 Mc/s is summarized. An effort is made to compare reports of dynamic spectra at radiofrequencies with flare data and single frequency records. The apparently close association between flares with "major early bursts" at frequencies ≤200 Mc/s and geomagnetic disturbances is discussed. A.

523.164.32 : 621.396.946

1438. A SWEPT-FREQUENCY INTERFEROMETER FOR THE STUDY OF HIGH-INTENSITY SOLAR RADIATION AT METER WAVELENGTHS. J.P.Wild and K.V.Sheridan.
Proc. Inst. Radio Engrs, Vol. 46, No. 1, 160-71 (Jan., 1958).

The instrument is a "swept-frequency" interferometer and is capable of measuring the one-dimensional position and angular size of a transient source on the sun's disk, and of determining the polarization and intensity of the received radiation. All these characteristics are determined as a function of frequency in the range 40-70 Mc/s. Independent position measurements are made at one-second intervals, and source-size measurements at two-second intervals. Polarization measurements are made as an alternative at chosen times. The two aerials of the main interferometer are spaced 1 km apart on an east–west line. The two aerials of the polarization system are erected on a common axis maintained in the direction of the sun. Some preliminary observations have given an indication of the spectrum of source size for activity of spectral Types I and III. In both cases the angular size is found to decrease from about 10 min of arc at 45 Mc/s to about 6 min of arc at 65 Mc/s. A.

523.164.32

1439. CRITICAL FREQUENCY, REFRACTIVE INDEX, AND CONE OF ESCAPE IN THE SOLAR CORONA.
R.N.Bracewell and C.V.Stableford.
Proc. Inst. Radio Engrs, Vol. 46, No. 1, 198-9 (Jan., 1958).

Nomograms give refractive index governing radio propagation in the solar corona and the semivertical angle of the cone of escape. A.

523.164.4

1440. RADIO SOURCES AND THE MILKY WAY AT 440 Mc.
N.G.Roman and B.S.Yaplee.
Proc. Inst. Radio Engrs, Vol. 46, No. 1, 199-204 (Jan., 1958).

The brighter radio-sources and two regions of the Milky Way were surveyed at 440 Mc/s with equipment mounted in a 50-foot radio-telescope. An attempt was made to keep the technique in this survey as similar as possible to that used at higher frequencies. Flux values are given for nine discrete sources and contour maps are presented for the section of the galactic plane near the north of the galactic centre and for the area near the strong radio source, Cygnus A. The results obtained for five of the discrete sources and for two lines across the Milky Way are compared with the results of other observers at other frequencies, in an attempt to study the radiofrequency spectra of astronomical objects. A.

523.164.4

1441. THE DISTRIBUTION OF COSMIC RADIO BACKGROUND RADIATION. H.C.Ko.
Proc. Inst. Radio Engrs, Vol. 46, No. 1, 208-15 (Jan., 1958).

The results of a survey of cosmic radio-background radiation at 250 Mc/s using the Ohio State University 96-helix radiotelescope are described. The aerial has beam widths of about 1.2° in right ascension and 8° in declination between half-power points. Radio maps, covering about 75% of the sky, are presented in celestial and galactic coordinates. The greater resolving power of the aerial has revealed a number of fine features of the background radiation as well as numerous radio-stars. Radio maps made at other frequencies by various groups are summarized. To present an over-all picture of the sky at different frequencies, eight maps are shown for frequencies from 64 Mc/s to 910 Mc/s. All maps are modified to have the

same scale, coordinates and units to facilitate intercomparison. An intercomparison of these radio maps shows some consistent features of the galactic background radiation. These features may be represented by three symmetrical distributions and several unsymmetrical or irregular distributions. The symmetrical distributions are as follows: (1) A narrow belt about 3° wide lying in the galactic plane and concentrated towards the galactic centre. (2) A very broad band of radiation concentrated within about 15° to 30° of galactic latitude and having its maximum near the galactic centre. (3) An approximately isotropic distribution. The first component indicates a mixture of thermal and nonthermal origin, while the other two are nonthermal. A.

523.164.4

1442. SPECTRAL LINES IN RADIO ASTRONOMY. A.H.Barrett.
Proc. Inst. Radio Engrs, Vol. 46, No. 1, 250-9 (Jan., 1958).

A review of the elements of microwave spectroscopy as it concerns, or is likely to concern, radioastronomy is presented. This review attempts to show how atomic and molecular resonance lines arise in the radio-frequency spectrum and to discuss the important parameters of spectral lines. Finally, it is shown how the intensity of radio emission received from the galaxy is modified by the presence of an interstellar atomic gas having a resonance transition at the frequency of observation. A.

523.164.42 : 525.722

1443. THE VARIATION WITH SIDEREAL TIME OF RADIO STAR SCINTILLATION RATES. G.C.Reid.
Canad. J. Phys., Vol. 35, No. 9, 1004-16 (Sept., 1957).

Long-term analysis of the scintillation rate of the radio star Cassiopeia A at a frequency of 50 Mc/s was carried out using data obtained at Ottawa and Saskatoon. It is found that the variation of scintillation rate with sidereal time can be explained by assuming the ionospheric irregularities responsible for the scintillations to be greatly extended along the direction of the earth's magnetic field, and to have a drift motion whose average direction appears to be around an axis passing through the earth's dip-pole. A.

523.164.42

1444. FLUX MEASUREMENTS OF CASSIOPEIA A AND CYGNUS A BETWEEN 18.5 Mc AND 107 Mc. H.W.Wells.
Proc. Inst. Radio Engrs, Vol. 46, No. 1, 205-8 (Jan., 1958).

Results of a series of measurements on the two most intense radio-stars are given. Basic techniques for absolute and relative intensity measurements are described. Principal sources of error are discussed with special attention to the very controversial range below 30 Mc/s. To minimize one common source of error, interferometer arrays using simple dipole aerials over reflecting screens were used for all absolute measurements of Cassiopeia A. For relative amplitude determinations, collinear arrays with higher resolution were employed. The absolute observations show flux densities which increase by a factor of two between 100 Mc/s and 40-50 Mc/s, and then continue a more gradual increase to 18.5 Mc/s. The amplitude of Cygnus A relative to Cassiopeia A is between 0.5 and 0.6 over the entire range of frequencies. A.

523.164.43

1445. HYDROGEN LINE STUDY OF STELLAR ASSOCIATIONS AND CLUSTERS. T.K.Menon.
Proc. Inst. Radio Engrs, Vol. 46, No. 1, 230-4 (Jan., 1958).

Describes the results of recent investigations at Harvard College Observatory on the interstellar structure around a number of stellar associations and clusters. The results were obtained from analyses of the 21 cm profiles of neutral hydrogen in these systems using 24 ft and 60 ft radio-telescopes. Investigations of the associations Orion I and Orion II showed expansion of neutral hydrogen around these associations. Preliminary results of studies of other associations Lacerta, Cygnus II, Cygnus VI, NGC 2244, and NGC 2264 are described. Observations of hydrogen content of some galactic clusters were found to show a strong age effect. The significance of these results for studies of stellar evolution is discussed. A.

523.164.43

1446. EXTRAGALACTIC 21 cm LINE STUDIES.
D.S.Heeschen and N.H.Dieter.
Proc. Inst. Radio Engrs, Vol. 46, No. 1, 234-9 (Jan., 1958).

The study of neutral hydrogen in extragalactic systems by means of its 21 cm line emission is a relatively new field of radio astronomy research. To date, radiation has been observed from seven galaxies and three clusters of galaxies. In this paper some of the results of these observations are described. Although the observational material presently available is quite limited, it does indicate the great potential power of extragalactic 21 cm line studies. A.

523.164.43

1447. EXCITATION OF THE HYDROGEN 21 cm LINE.
G.B.Field.
Proc. Inst. Radio Engrs, Vol. 46, No. 1, 240-50 (Jan., 1958).

The importance of spin temperature for 21 cm line studies is reviewed, and four mechanisms which affect it are studied. Two of the mechanisms, collisions with free electrons and interactions with light, are studied in detail. The results are summarized in the form of certain effeciencies which can be used to calculate the spin temperature. The results are applied to a variety of astronomical situations, and it is shown that in the usual situation collisions with H atoms are very effective in establishing the spin temperature equal to the kinetic temperature. Under conditions of low-density and/or high-radiation intensity, however, important deviations from the usual are noted. The significance of such deviations for absorption studies of radio sources and the galactive halo is discussed. The deuterium line at 91.6 cm is considered in like fashion. It is shown that for deuterium also, the spin temperature probably is close to the kinetic temperature. A.

523.164.83

1448. LUNAR RADIO ECHOES. J.H.Trexler.
Proc. Inst. Radio Engrs, Vol. 46, No. 1, 286-92 (Jan., 1958).

High-power radars were used to study the reflecting properties of the earth's moon. Experimental work over the last six years at frequencies in the 30 Mc/s to 3000 Mc/s band has revealed a lunar surface phenomena which produces a "highlight". Measurements made at 198 Mc/s have shown that more than 50% of the echo energy is reflected in the first 50 microseconds after the leading edge of a short incident pulse contacts the moon. This fortunate situation permits many interesting astronomical observations and suggests the use of wideband communication signals in a circuit using the moon as a passive relay. Many types of modulation have been successfully passed over the lunar circuit, including amplitude modulation by voice. A.

523.164.85

1449. THE FORWARD-SCATTERING OF RADIO WAVES FROM OVERDENSE METEOR TRAILS. C.O.Hines and P.A.Forsyth.
Canad. J. Phys., Vol. 35, No. 9, 1033-41 (Sept., 1957).

The forward-scattering of radio waves from overdense meteor trails is treated from an elementary point of view. The results indicate that the same geometric factors enter this problem as enter the problem of forward-scattering from underdense trails, and that the transition between underdense and overdense trails occurs at the same value of charge density as in the backscatter case. These conclusions are not expected to be generally valid when applied to individual trails, but at least they should provide a valid basis for the interpretation and prediction of the effects produced statistically by a large number of trails. A.

523.164.85

1450. DIURNAL VARIATIONS IN THE NUMBER OF SHOWER METEORS DETECTED BY THE FORWARD-SCATTERING OF RADIO WAVES. III. ELLIPSOIDAL THEORY. C.O.Hines.
Canad. J. Phys., Vol. 36, No. 1, 117-26 (Jan., 1958).

For Pt II see Abstr. 881 (1956). The application of the theory to data obtained during meteor showers provides a promising new method for studying the intrinsic strengths of the showers. The principal limitation of the method is due to the inaccuracies of the cylindrical approximation. In the present paper, these inaccuracies are removed by a full development of the ellipsoidal geometry inherent in the forward-scatter process. The more rigorous results are compared with the approximate results at various stages throughout the analysis. A.

523.165 : 523.75 : 537.591

1451. INITIAL STAGES IN THE PROPAGATION OF COSMIC RAYS PRODUCED BY SOLAR FLARES. R.Lüst and J.A.Simpson.
Phys. Rev., Vol. 108, No. 6, 1563-76 (Dec. 15, 1957).

The propagation of solar cosmic-rays produced in the February 23, 1956 flare has been studied from the time they leave the flare region to the time when the terrestrial cosmic-ray intensity reaches a maximum value. Within this interval there are observed not only strong anisotropies in the incident radiation, but also relatively large differences in time ($\leq$ 9 minutes) between the commencements of the intensity increases in different parts of the world. This distribution of time delays is superposed upon the transit-time delay which all particles experience between production and detection. From these

experimental results, and the calculations of orbits connecting the sun and earth at the time of the flare, it is shown that there are broad impact zones on the earth within the first ten minutes of the cosmic-ray intensity increases. Using the recently deduced flare-particle spectrum, cosmic-ray intensities at the top of the atmosphere have been determined for the different impact zones. For this flare event the "2000 hour" impact zone becomes as important as the "0900" and "0300" hour impact zones. These results demonstrate that the first flare particles arriving at the earth were not of low energy, and that the low-energy particles arrived later – the delay being an inverse function of energy. This energy-dependent spread of first arriving particles is called the dispersion effect arising from the mode of particle propagation from the flare source to the earth. These conclusions show that back scattering from disordered magnetic fields beyond the orbit of the earth does not account for the time delays. Various alternatives are considered for production of this distribution of onset times. The most likely process appears to be propagation through magnetic fields by diffusion. Since the impact-zone data for all geomagnetic latitudes, including both polar regions, predict a distant source in the direction of the sun but of order one radian solid angle in the sky, and since sufficient diffusion around the earth to produce the required time delays would destroy the observed impact-zone effects, it is suggested that there may exist a diffusing envelope around the sun which accounts for both the apparent source size and the dispersion effect. Small irregularities in the general solar dipole field are invoked to produce the diffusion. Calculations show that the predicted dispersion effect agrees with the observations, and that other details following from diffusion are satisfied. There is evidence of a dispersion effect for the flare particles of November 19, 1949. The implications of these results for possible uniform magnetic-field distributions between the sun and earth are reviewed, and it is shown from the orbit calculations and the dispersion effect that the predictions are not in agreement with observations. There is a transition period between the time when impact zones are dominant and the time when isotropy sets in. The subsequent storage of the solar cosmic-ray particles is not further considered in this paper, except for the bearing of these observations at early times upon the character of the interplanetary storage magnetic fields. A.

523.165 : 537.591

1452. ORIGIN AND DYNAMICS OF COSMIC RAYS. E.N.Parker.
Phys. Rev., Vol. 109, No. 4, 1328-44 (Feb. 15, 1958).

As a consequence of the inability to observe directly the origin of a cosmic-ray particle, a discussion is given of the limitations within which one can construct a cosmic-ray accelerator mechanism. Only the betatron effect and the Fermi mechanism are found to be allowed. Some of the many variations of these mechanisms which are to be found in the literature are reviewed. Then it is shown that trains of oppositely moving hydromagnetic waves of large amplitude and with sharp crests can accomplish large and continued particle accelerations which are adequate to maintain the observed galactic cosmic-ray field. The large acceleration arises as a consequence of the simple fact that each wave tends to sweep up the cosmic-ray particles before it, so that head-on collisions of particles with waves are much more common than overtaking collisions. It is pointed out that the sharp crests of the waves are a natural consequence of the observed supersonic mass motions. Therefore, the acceleration by oppositely moving waves does not depend upon any special waveform, and it is suggested that it is the naturally occurring acceleration process. By treating the cosmic rays as a gas with relativistic thermal motions, it is shown that the cosmic-ray gas is effectively coupled to the motions of the ordinary matter both parallel and perpendicular to the magnetic field. Thus the effective speed of sound must be computed in the composite cosmic-ray and ordinary gas. It is noted that with this composite speed of sound the irregular mass motions in the galactic disk and halo are approximately Mach one. It is suggested that this represents a general dynamic balance to be found in all sufficiently active regions of space, and explains how it is that one often observes prolonged mass motions in the galaxy and in stellar atmospheres which would otherwise be computed to be highly supersonic and dissipative. The dynamic balance comes about from the fact that increased cosmic-ray density would reduce the effective Mach number below one, allowing the sharp crests of the hydromagnetic waves to degenerate, and thereby halting the production of cosmic-ray particles. A.

523.5 : 523.164.85

1453. VARIATION IN THE OCCURRENCE RATE OF METEORS. G.S.Hawkins.
Astron. J., Vol. 61, No. 9, 386-91 (Nov., 1956).

Radio-echo observations are used to estimate the total influx of meteors on the earth's surface. The approximate distribution of sporadic meteor radiants is deduced by a statistical method, and from this distribution the diurnal variation in the occurrence rate of meteors is computed for geographical latitudes 0°, 30°N, 50°N, and 80°N. The variation is greatest at the equator and becomes progressively smaller at the higher latitudes. A.

523.53

1454. METEOR SIGNAL RATES OBSERVED IN FORWARD-SCATTER. E.L.Vogan and L.L.Campbell.
Canad. J. Phys., Vol. 35, No. 10, 1176-89 (Oct., 1957).

Diurnal and seasonal variations in meteor signal rate observed during a 15 month period over a forward-scatter path situated in eastern Canada are discussed. Measurements were made at a frequency of 49.98 Mc/s. The data show a large spread from hour to hour and day to day with the greatest signal rate being observed during the summer months. The influence of ionospheric absorption on the signal rate observed during the morning hours is considered and it is concluded that the presence of a small amount of attenuation can modify appreciably the form of the diurnal variation. A.

523.746.5

1455. A REVIEW OF RECENT INVESTIGATIONS INTO SUN-SPOT CYCLES. N.A.Huttly.
Marconi Rev., Vol. 20, 117-29 (4th Qtr, 1957).

A critical review of some recent (1939-1956) papers on sunspot cycles. A selection of papers was made which typified the many different approaches to a means of forecasting sunspot numbers. In addition to the papers under review, a short list of other references is included whilst still more references can be found from the quoted papers themselves. A short note on the behaviour of the present sunspot cycle is also given. A.

523.75 : 523.164.32

RADIO-FREQUENCY RADIATION AT THE TIME OF SOLAR FLARES. See Abstr. 1437

523.873

1456. STELLAR ENERGY SOURCES. E.E.Salpeter.
Rev. mod. Phys., Vol. 29, No. 2, 244-53 (April, 1957).

International Congress review paper (see Abstr. 5814/1957).

525.3 : 523.164.8

1457. RADIO OBSERVATIONS OF THE [FIRST] RUSSIAN EARTH SATELLITE.
Nature (London), Vol. 180, 879-83 (Nov. 2, 1957).

This paper reports the results obtained by the staff of the Mullard Radio Astronomy Observatory, Cambridge. Observations of the six or seven transits per night, observable from Cambridge, were made from October 6 onwards, mostly on 40 Mc/s, but with some additional observations on 20 Mc/s and 80 Mc/s. The positions were measured with an interferometer which could be used with two perpendicularly-polarized aerials. Doppler measurements were made by beating with a standard 40 Mc/s oscillator. The graphical methods used to compute a preliminary orbit are described, and elements of this orbit given. The variation of intensity, together with polarization measurements on two wavelengths, yield the spin period of the satellite ($\frac{1}{7}$ minute) and a measure of the atmospheric Faraday effect. This and other methods of determining atmospheric electron densities are briefly discussed. For one set of observations, a total electron content to 475 km was estimated to be $1.8 \times 10^{13}\,cm^{-2}$. From the secular decrease of orbital period, it is estimated that the satellite encountered 1.8 g of material per revolution. The retrograde motion of the ascending node ($2^{\circ}33' \pm 5'$ per day) is inconsistent with the accepted figure of the earth. M.W.Ovenden

525.3 : 523.164.8

1458. OBSERVATIONS ON THE ORBIT OF THE FIRST RUSSIAN EARTH SATELLITE.
Nature (London), Vol. 180, 937-41 (Nov. 9, 1957).

This paper reports the results obtained by the staff of the Royal Aircraft Establishment, Farnborough. Interferometric observations were made on 40 Mc/s. The construction of the interferometer and its calibration using an aircraft, are described. A preliminary, approximate calculation of an orbit by a method described is used to suggest a range of possible orbits, which are then calculated in detail by a digital computer, and compared with the observations. Doppler observations were also made from a number of stations, and their value for orbital determinations is discussed. The general characteristics of the orbit are discussed, including drag effects which give an atmospheric density at 130 miles as 2×10^{-10} of that at sea level. Fading attributed to atmospheric Faraday effect and satellite spin has been observed, but it is not analysed. The long duration (~ 30 min) of the signals at transit is unexplained. M.W.Ovenden

525.3 : 523.164.8

1459. RADAR OBSERVATIONS OF THE FIRST RUSSIAN EARTH SATELLITE AND CARRIER ROCKET.
Nature (London), Vol. 180, 941-2 (Nov. 9, 1957).

This paper reports the results obtained by the staff of the Jodrell Bank Experimental Station, University of Manchester. Emergency arrangements for the use of the Jodrell Bank steerable radio-telescope as a radar transmitter on 120 Mc/s and 36 Mc/s, using pulsed beams, are described, and a typical echo from the carrier rocket is reproduced. M.W Ovenden

525.3 : 523.164.8

1460. FURTHER RADIO OBSERVATIONS OF THE FIRST SATELLITE. I.R.King, G.C.McVittie, G.W.Swenson, Jr and S.P.Wyatt,Jr; N.Lea.
Nature (London), Vol. 180, 943, 943, 944 (Nov. 9, 1957).

At the University of Illinois Observatory, interferometric observations were made during the period October 5-24, on 20 Mc/s and on 40 Mc/s. The period of the satellite during this interval can be represented by $96^m\ 09^s.8 - 0^s.1293n - 7^s.797 \times 10^{-5}n^2$, where n is the number of revolutions since the southbound crossing of latitude parallel 40° 1'.1 N on October $5^d\ 13^h\ 30^m\ 01^s$ U.T. The regression of the nodes was such that the local mean solar time of southbound crossing of the same parallel is given by $(8^h\ 11^m \pm 2^m) - (1^m.100 \pm 0^m.006)n$.

At Chelmsford, the Doppler effect was measured between October 9 and 24, with the 40 Mc/s transmission, by a method that allows for a possible signal modulation arising at the source or during propagation. A curve of zero-Doppler frequencies is given. Slant ranges from the rate of change of frequency covered the range 224-1500 km.

A note from the Ministry of Supply reports installation of radar equipment in the radio-telescope at the Royal Radar Establishment, Malvern and first observations made on a wavelength of 10 cm. M.W.Ovenden

525.3

1461. ROCKET OF THE FIRST EARTH SATELLITE.
Nature (London), Vol. 180, 944 (Nov. 9, 1957).

Photographic and visual observations from Ireland (Dunsink Observatory) on October 11-16 are consistent with a height of 430 km, and an orbital period of $95^m\ 53^s$ at October $11^d.23$, decreasing uniformly by $4^s.13$ per day. The corresponding decrease in semi-major axis is 3.4 km per day, and the node precesses at approximately $3^o.3$ per day. M.W.Ovenden

525.3 : 523.164.8

1462. THE 45 FT RADIO TELESCOPE AT THE ROYAL RADAR ESTABLISHMENT, MALVERN.
Nature (London), Vol. 180, 1225-8 (Dec. 7, 1957).

This paper comes from the staff of the Establishment. The electrical and mechanical characteristics of an aerial designed for radio and radar astronomy at centimetric wavelengths are described. Specimen echoes from the first artificial satellite and from the moon are shown. M.W.Ovenden

525.3

1463. LIFE-TIME OF AN ARTIFICIAL EARTH SATELLITE. J.A.Fejer.
Nature (London), Vol. 180, 1413 (Dec. 21, 1957).

It is shown that the future lifetime of a satellite, from an epoch when its orbital semi-major axis is h_1 and its rate of loss of height at apogee is h'_a, is given (approximately) by h_1/h'_a. M.W.Ovenden

525.3

1464. ESTIMATING THE LIFE OF A SATELLITE. J.M.C.Scott.
Nature (London), Vol. 180, 1467-8 (Dec. 28, 1957).

It is shown that, for a spherical earth and small orbital eccentricity, the value at time t of A [$A = \frac{1}{2}(h_{max} - h_{min})$, where h_{max} and h_{min} are maximum and minimum heights of the satellite] is given by $C_3(t_0 - t)^{1/3}$, where C_3, t_0 are constants. The remaining lifetime of the satellite is given by

$$(t_0 - t) = \frac{3\pi}{4v} \cdot \frac{2A}{(-dT/dt)},$$

where v is the velocity of the satellite and dT/dt is the rate of change of its period. M.W.Ovenden

525.3 : 523.164.8

1465. SCIENTIFIC OBSERVATIONS OF THE ARTIFICIAL EARTH SATELLITES AND THEIR ANALYSIS.
H.S.W.Massey and R.L.F.Boyd.
Nature (London), Vol. 181, 78-80 (Jan. 11, 1958).

A report of the discussion arranged by the Royal Society on November 29, 1957. Reference is made to radar and radio position measurements, Doppler measurements, the difficulties in orbital computation, and possibilities for ionospheric research. Some orbital details for the three components of "Sputnik 1" and for "Sputnik 2" are given. M.W.Ovenden

525.3 : 523.164.8

1466. OBSERVATIONS IN AUSTRALIA OF RADIO TRANSMISSIONS FROM THE FIRST ARTIFICIAL EARTH SATELLITE. G.H.Munro and R.B.White.
Nature (London), Vol. 181, 104 (Jan. 11, 1958).

Observations were made on 20 Mc/s using a quarter-wave vertical dipole and a sensitive, highly selective receiver. The signals showed a slow variation with a period of about 5 sec, and a faster deep fading of variable periodicity. The faster fading-rate varies according to a regular pattern, and similar effects occur on simultaneous 40 Mc/s records made with less satisfactory equipment. The slow fading is considered to be a feature of the transmissions, and the fast fading to be due to interference between ordinary and extraordinary components. M.W.Ovenden

PHYSICS

FUNDAMENTALS

530.12

1467. PHENOMENOLOGICAL LINEAR THEORY OF GRAVITATION. III. INTERACTION WITH THE SPINNING ELECTRON.
F.J.Belinfante and J.C.Swihart.
Ann. Phys. (New York), Vol. 2, No. 1, 81-99 (July, 1957).

A Lorentz-covariant, linear theory of gravitation interacting with the electromagnetic field as well as with matter was developed in two preceding papers (Abstr. 8364-5/1957), in which matter was treated as consisting of classical point masses. The present part treats the simultaneous interaction of this gravitational field with the electromagnetic field and with spinning electrons described wave-mechanically by Dirac's spinor or "undor" field. In the presence of the gravitational field, the usual interpretation of this undor field ψ as a probability amplitude needs modification. It is possible to define a field φ which takes the place of ψ as the probability amplitude. It is shown then that wave-packets built up from these probability waves obey (but for some negligible spin terms) the same equations of motion as classical point particles in the "classical" limit in which both momentum and position of the wave-packet are given with sufficient accuracy. The red shift of spectral lines emitted in a gravitational field is uniquely determined and is not influenced by the previously discussed uncertainty about the values of some of the constants in the Lagrangian. The theory predicts for this red shift the same value as on quite different grounds is predicted by Einstein's theory. For both theories, there is no agreement between the predicted red shifts and the observed ones, probably as a result of other influences on the spectrum which are not fully understood. A.

530.12 : 538.3

1468. CLASSICAL PHYSICS AS GEOMETRY. GRAVITATION, ELECTROMAGNETISM, UNQUANTIZED CHARGE, AND MASS AS PROPERTIES OF CURVED EMPTY SPACE.
C.W.Misner and J.A.Wheeler.
Ann. Phys. (New York), Vol. 2, No. 6, 525-603 (Dec., 1957).

If classical physics be regarded as comprising gravitation, source free electromagnetism, unquantized charge, and unquantized mass of concentrations of electromagnetic field energy (geons), then classical physics can be described in terms of curved empty space, and nothing more. No changes are made in existing theory. The electromagnetic field is given by the "Maxwell square root" of the contracted curvature tensor of Ricci and Einstein. Maxwell's equations then reduce, as shown thirty years ago by Rainich, to a simple statement connecting the Ricci curvature and its rate of change. In contrast to unified field theories, one then secures from the standard

theory of Maxwell and Einstein an "already unified field theory". This purely geometrical description of electromagnetism is traced out in detail. Charge receives a natural interpretation in terms of source-free electromagnetic fields that (1) are everywhere subject to Maxwell's equations for free space but (2) are trapped in the "worm holes" of a space with a multiply-connected topology. Electromagnetism in such a space receives a detailed description in terms of the existing beautiful and highly developed mathematics of topology and harmonic vector fields. Elementary particles and "real masses" are completely excluded from discussion as belonging to the world of quantum physics. A.

530.12 : 538.3

1469. ON THE NATURE OF QUANTUM GEOMETRODYNAMICS. J.A.Wheeler.
Ann. Phys. (New York), Vol. 2, No. 6, 604-14 (Dec., 1957).

Classical gravitation, electromagnetism, charge, and mass are described in the preceding abstract in terms of curved empty space and nothing more. In advance of the detailed quantization of this pure Einstein–Maxwell geometrodynamics, an attempt is made here (1) to bring to light some of the most important properties to be expected for quantized geometrodynamics and (2) to assess whether this theory, without addition of any inventive elements, can contribute anything to the understanding of the elementary particle problem. Gravitational field fluctuations are concluded to have qualitatively new consequences at distances of the order of $(\hbar G/c^3)^{1/2} = 1.6 \times 10^{-33}$ cm. They lead one to expect the virtual creation and annihilation throughout all space of pairs with electric charges of the order $\sim (\hbar c)^{1/2}$ and energies of the order $(\hbar c^5/G)^{1/2} = (2.18 \times 10^{-5}\ \mathrm{g})c^2 = 2.4 \times 10^{22}\ mc^2$. The problem is discussed, to what extent these charges can be identified with the unrenormalized or "undressed" charges of electron theory. Decisive for the future usefulness of quantum geometrodynamics is the question whether spin shows itself as an inevitable geometrical concomitant of quantization, or whether it and other ideas have to superposed on this purely geometrical description of nature. A.

530.12

1470. PROOF OF THE NON-EXISTENCE OF PERIODIC GRAVITATIONAL FIELDS REPRESENTING RADIATION. A.Trautman.
Bull. Acad. Polon. Sci. Cl. 3, Vol. 5, No. 12, 1115-17 (1957).

It is shown that there exist no exact, periodic solutions of Einstein's equations with matter, representing radiation. A periodic gravitational field $g_{\mu\nu}$ is defined here such that $g_{\mu\nu}(x^0 + \tau, x^\kappa) = g_{\mu\nu}(x^0, x^\kappa)$, where τ is a number, and

$$\left|g_{\mu\nu} - \eta_{\mu\nu}\right| < \frac{M}{r}, \left|g_{\mu\nu,\rho}\right| < \frac{M}{r},$$

where M is a constant, and $\eta_{\mu\nu}$ is the metric tensor of flat space-time. Radiation is understood as energy escape to infinity. G.Stephenson

530.12

1471. ON THE GRAVITATIONAL EFFECT OF SPIN. O.Costa de Beauregard.
C.R. Acad. Sci. (Paris), Vol. 245, No. 25, 2199-201 (Dec. 16, 1957). In French.

A material field with intrinsic spin is described in terms of an asymmetric curvature tensor. It is postulated that there are two equivalent developments of the theory, (i) in terms of asymmetric g^{ij} and symmetric energy-momentum tensor T^{ij}, and (ii) in terms of symmetric g^{ij} and asymmetric T^{ij}. With $T^{ij} = \rho U^i V^j$ there are gravitational effects of spin if U_i is the 4-vector velocity and V_i the direction of the 4-vector momentum, but there are no such effects if the roles of U_i and V_i are interchanged. R.A.Newing

530.12

1472. ON THE PERIHELION SHIFT IN CONFORMALLY FLAT SPACE-TIME. A.Das.
Nuovo Cimento, Vol. 6, No. 6, 1489-90 (Dec., 1957).

It is shown that the motion of the perihelion of Mercury according to the conformally flat space-time theory developed by Littlewood (Abstr. 4585/1953) agrees with the result obtained by Pirani (Abstr. 7674/1955). An error in the calculation given by Gursey (Abstr. 4586/1953) is pointed out. G.Stephenson

530.12

1473. A CLASS OF EXACT SOLUTIONS OF THE COMBINED GRAVITATIONAL AND ELECTRO-MAGNETIC FIELD EQUATIONS OF GENERAL RELATIVITY. R.L.Brahmachary.
Nuovo Cimento, Vol. 6, No. 6, 1502-6 (Dec., 1957).

A solution of the Einstein–Maxwell theory is obtained corresponding to a spherically symmetric matter distribution around a charged sphere of finite radius. G.Stephenson

530.12

1474. ON THE MOTION OF CHARGED PARTICLES IN THE COMPLEX-SYMMETRIC UNIFIED FIELD THEORY. J.Moffat.
Nuovo Cimento, Vol. 7, No. 1, 107-9 (Jan. 1, 1958).

The equations of motion of a charged particle in the complex unified field theory (see Proc. Camb. Phil. Soc., 53, 473, 1957) are derived by applying the "dipole procedure" proposed by Infeld and Plebanski (Abstr. 5025/1957). The gravitational dipoles are put equal to zero after the field equations have been solved, but the electromagnetic dipoles cannot be removed in this way without leading to inconsistencies in the equations of motion. Physically significant electromagnetic dipole forces therefore occur together with the Lorentz force. G.Stephenson

530.12

1475. THREE LECTURES ON RELATIVITY THEORY. V.Fock.
Rev. mod. Phys., Vol. 29, No. 3, 325-33 (July, 1957).

First Lecture: On Homogeneity, Covariance and Relativity. This deals mainly with the reasons for using the harmonic coordinate conditions

$$\frac{\partial}{\partial x^k}\left(\sqrt{-g}\, g^{ik}\right) = 0$$

in general relativity.

Second Lecture: Some approximate solutions of Einstein's equations for the motion of rotating bodies of finite size are obtained using the harmonic coordinate conditions.

Third Lecture: It is shown that there exist solutions of Einstein's equations in harmonic coordinates corresponding to spherical gravitational waves emitted by a system of moving bodies. G.Stephenson

530.12

1476. EINSTEIN'S AND OTHER THEORIES OF GRAVITATION. S.N.Gupta.
Rev. mod. Phys., Vol. 29, No. 3, 334-6 (July, 1957).

A short review is given of Lorentz covariant theories of gravitation with particular reference to Nordstrom's scalar field theory (spin 0), the four-vector theory (spin 1), and to Birkhoff's symmetric tensor theory (spin 2). It is shown how Einstein's theory may be reduced to a theory of gravitation in flat space by an expansion of the gravitational Lagrangian density as an infinite series in powers of the gravitational coupling constant (see Abstr. 3267, 7920/1952). G.Stephenson

530.12

1477. ELECTRICITY AND GENERAL RELATIVITY. C.Lanczos.
Rev. mod. Phys., Vol. 29, No. 3, 337-50 (July, 1957).

A theory based on the quadratic Lagrangian $R_{ik}R^{ik} + \beta R^2$, where β is a constant, and R and R_{ik} are contractions of the Riemann–Christoffel tensor, leads to the following results: (a) the existence of a four-vector (as a result of a canonical transformation) associated with the electromagnetic charge-current and determined by a second order differential equation, (b) the basic equations are satisfied by the cosmological equations $R_{ik} = \lambda g_{ik}$, where λ is a constant which fixes the basic unit of length, (c) the existence of a background field performing ultra-high-frequency oscillations of small amplitude which are too small to be observed in macroscopic situations. It is suggested that the quantum uncertainty principle may be connected with the statistical nature of this background field. G.Stephenson

530.12

1478. SUMMARY OF THE CHAPEL HILL CONFERENCE. P.G.Bergmann.
Rev. mod. Phys., Vol. 29, No. 3, 352-4 (July, 1957).

This conference on the Role of Gravitation in Physics was held at the University of North Carolina in January 1957. It may be summarized under two main headings, classical theory of gravitation and quantization of general-relativistic theories; a third topic, the theory of measurement, forms a link between these two topics. Abstracts of the individual papers appear under their appropriate headings. A.

530.12

1479. EQUATIONS OF MOTION IN GENERAL RELATIVITY THEORY AND THE ACTION PRINCIPLE. L.Infeld.
Rev. mod. Phys., Vol. 29, No. 3, 398-411 (July, 1957).

Detailed calculations are given for the derivation of the post-Newtonian equations of motion from the field equations $R_{ik} - \frac{1}{2}g_{ik}R = -kT_{ik}$, where T_{ik} is proportional to Dirac's δ function. It is claimed that, up to this order, the equations of

motion are independent of the harmonic coordinate conditions

$$\frac{\partial}{\partial x^k}(\sqrt{-g}\,g^{ik}) = 0$$

imposed by Fock, and depend only on the approximation procedure. A suitable choice of coordinate system appears to remove all contributions to the equations of motion beyond the fourth order.

G.Stephenson

530.12

1480. CORRESPONDENCE IN THE GENERALIZED THEORY OF GRAVITATION. B.Kurşunoğlu.
Rev. mod. Phys., Vol. 29, No. 3, 412-16 (July, 1957).

The role of the fundamental length r_0 in the theory proposed by the author (Abstr. 1359/1953) is discussed in detail, and it is shown that in the limit $r_0 = 0$ gravitational equations together with Maxwell's equations for charge-free fields are obtained. The existence of r_0 implies an extended charge distribution for elementary particles. G.Stephenson

530.12 : 530.145

1481. GENERAL RELATIVITY AND THE DIVERGENCE PROBLEM IN QUANTUM FIELD THEORY. S.Deser.
Rev. mod. Phys., Vol. 29, No. 3, 417-23 (July, 1957).

Many profound reasons are given why general relativity may play a decisive role in elementary particle problems, in contrast to some current beliefs. The problem of singularities in the matter propagators is discussed at length. The method used is Feynman's functional integration: the vacuum expectation value of the operator of interest is the functional integral of a corresponding c-number quantity over all classical configurations of the system. It may be expected that the contributions of the "scalar" and "transverse" parts of the gravitational field will limit the density of matter in a certain region and will "smear out" the light cone at the same time for the particle, insofar as the summation over all possible Riemann spaces will average away the uniqueness of the Minkowski light cone and with it the singularities of the propagators. Further, even though the strong nonlinearity due to the gravitational field makes the relations between propagators and physical observables more complicated than in the usual theory, they still determine the theory and their singularities, if any, are still the relevant ones. It is shown that the singularities corresponding to point particles and interactions indeed disappear as indicated by a qualitative estimate of the gravitationally corrected matter propagators. Corroborative arguments are furnished by consideration of the energy-momentum vector and its commutation relations. Picturesquely speaking, one could say that the obtained nonsingularity of both the matter field and gravitational field propagators is due to the fact that one could never force such a concentration of energy of a field that its gravitational couplings would cease to matter, because the induced geometry would cause a repulsion before this stage could be reached.

P.Roman

530.12

1482. GRAVITATIONAL FIELD OF AN AXIALLY SYMMETRIC SYSTEM IN FIRST APPROXIMATION. N.Rosen and H.Shamir.
Rev. mod. Phys., Vol. 29, No. 3, 429-31 (July, 1957).

It is shown that Einstein's equations in empty space admit, in the linear approximation, a solution corresponding to gravitational waves emitted by two oscillating particles. The rate of emission of energy is calculated using the energy-momentum pseudo-tensor.

G.Stephenson

530.12

1483. THERMAL GEONS. E.A.Power and J.A.Wheeler.
Rev. mod. Phys., Vol. 29, No. 3, 480-95 (July, 1957).

As was shown previously by the second author (Abstr. 2395/1955), an electromagnetic field of appropriate character and energy density can hold itself together by its own gravitational attraction for a long time in comparison with the characteristic periods of the field oscillations; or, a sufficiently strong gravitational field can guide an electromagnetic wave and confine its energy to a bounded region of space. Such systems are termed geons and in the present paper solutions are obtained and a very detailed analysis is given for what are called "thermal geons", characterized by the following properties: (1) The gravitational field is static and spherically symmetric. (2) Each independent mode of vibration of the electromagnetic field is idealized to fall into one or other of the following two classes: (a) the energy of modes remains trapped for all time; (b) the vibrations carry energy freely to infinity. (3) All free modes are assigned zero energy whereas each bound mode of frequency ω is assumed to have an excitation $\hbar\omega[-1 + \exp(\hbar\omega/T)]^{-1}$. All properties of these geons are specified by the single parameter T which may be called temperature. P.Roman

530.12

1484. LINEAR AND TOROIDAL GEONS. F.J.Ernst, Jr.
Rev. mod. Phys., Vol. 29, No. 3, 496 (July, 1957).

A brief account is given of investigations related to the description of Wheeler's geons, namely of the two types when the electromagnetic field energy is spread over an infinitely long line, and, respectively, is concentrated in a toroidal region of space. P.Roman

530.12 : 530.145

1485. FEYNMAN QUANTIZATION OF GENERAL RELATIVITY. C.W.Misner.
Rev. mod. Phys., Vol. 29, No. 3, 497-509 (July, 1957).

The Feynman method is preferred for quantizing general relativity, because it allows some of the simpler problems to be tackled in isolation. Thus, a few simple observables might be constructed without knowing the algebra of all the operators. Also, by using instead of state vectors functionals of field configurations, definition of the scalar product in Hilbert space is deferred. The usual method of weighting the histories in the Feynman integral for a simple field, ϕ, is recognized as being invariant under the permutation group $\phi \rightarrow \phi + \chi$. In general relativity, it is suggested that the corresponding group should be $g_{\mu\nu} \rightarrow \pi^{\alpha}_{\mu}\, g_{\alpha\beta}\, \pi^{\beta}_{\nu}$. This defines the weighting in a manner which is consistent with a proper treatment of the gauge transformations and which allows special reference to the metric $g_{\mu\nu} = \mathrm{diag}(-1,1,1,1)$. The operator form of the field equations is deduced. Because of the topological invariance of general relativity, the state functionals must be the same on two topologically equivalent hypersurfaces. This means that the Hamiltonian operator vanishes. J.C.Taylor

530.145

1486. ψ SUPERPOSITION AND QUANTUM PERIODICITY. A.Landé.
Phys. Rev., Vol. 108, No. 3, 891-3 (Nov. 1, 1957).

The superposition law for probability amplitudes, usually considered as an empirical rule and introduced into the quantum theory as an ad hoc assumption, is shown to be the mathematical solution of almost self-evident requirements for the structural metric of the probabilities in general. When combining the general ψ-metric of superposition with the postulate of a constant probability density in q-space for given p, and of a constant probability density in p-space for given q, one arrives at the mathematical result that $\psi(q,p)$ must necessarily have complex periodic form, $\exp(iqp/\mathrm{const})$. Various quantum principles can thus be reduced to a nonquantal basis.

A.

530.145

1487. IMPROPER LORENTZ TRANSFORMATIONS. J.A.McLennan, Jr.
Phys. Rev., Vol. 109, No. 3, 986-9 (Feb. 1, 1958).

The irreducible representations of the extended Lorentz group, including the space- and time-like reflections, are discussed. It is shown that there exist certain representations (up to the sign) which can be used to describe a particle with two states of opposite parity.

A.

530.145

1488. MASS—ENERGY RELATION IN QUANTUM THEORY. W.F.G.Swann.
Phys. Rev., Vol. 109, No. 3, 998-1017 (Feb. 1, 1958).

It does not seem to be generally recognized that the mass—energy relation is not contained implicitly in the quantum theory, but is something superposed upon it, and without any clear guarantee as to its consistency with that theory. Even classical relativistic particle dynamics does not provide an explanation of "rest-mass defect". The first step in the paper is to produce a theory of rest-mass defects founded upon a concept in which a nucleon consists of a number of sub-particles, or "specks" as they will be called, which specks obey conservation of relativistic energy and momentum in a suitably chosen frame of reference, and with rest-masses which are regarded as absolute constants. The theory leads to a situation in which the nucleons act as individual entities conserving momentum as a whole but with rest-masses which can vary with the mutual proximities of the nucleons one to another. However, in place of a corresponding conservation of kinetic energy, there is conservation of $\Sigma(\tau_n + m_{0n}c^2)$, where τ_n is the ordinary relativistic kinetic energy, so that $\tau_n = m_{0n}c^2[(1-\beta_n^2)^{-1/2}-1]$. So far there is no mention of potential energy. However, at this stage it is postulated that the m_{0n} vary with the relative coordinates of the nucleons so that $m_{0n}c^2$ really becomes the representative of what is ordinarily regarded as a potential energy V. Indeed, $m_{0n}c^2$ becomes V + const., thus arriving at $\tau_n + V = \mathrm{const.}$, but with the m_{0n} occurring in τ_n being functions of

relative coordinates. Normally, the next procedure would be to express τ_n in terms of the relativistic momentum, and then replace the momentum by the usual operator to form an equation for the ψ function. A transformation to centre-of-gravity coordinates and relative coordinates might be expected to lead to an expression for ψ of the form $\psi = \phi\chi$, where ϕ is a function only of the relative coordinates and χ is a function of the centre-of-gravity coordinates. It might then be expected that the mass–energy relation could reveal itself in the fact that the equation for χ represented that of a single entity moving with constant velocity and with a rest mass $\Sigma m_{n\infty} - \epsilon_B/c^2$, where $m_{n\infty}$ are the rest-masses of the nucleons when at infinity, and ϵ_B is binding energy which, in turn, would be yielded by the ϕ equation, as the negative of the lowest eigenvalue for the energy in that equation. Realization of this form for the rest-mass of the nucleus is the aim of the paper. The ψ equation formed from the classical relativistic Hamiltonian in the above manner is of nonlinear form, and it resists an immediate accommodation of itself to the above procedure. However, by use, for the nucleus, of a "pseudomomentum" slightly different from the true relativistic momentum as the quantity which is to be replaced by the operator, and by a slight change in the manner of making the transformation to the operator form, the desired results are achieved. Both modifications of the normal procedure revert to that procedure for the case of small velocities.

A.

530.145

1489. TRANSFORMATION GROUPS IN A Q-NUMBER CONFIGURATION SPACE. I.Goldberg.
Rev. mod. Phys., Vol. 29, No. 3, 450-1 (July, 1957).

A programme is discussed for extending a classical transformation group in configuration space to a quantum theory based on a q-number Lagrangian. The postulated dynamical principle is the isomorphism between the transformation group in configuration space and the unitary transformations in Hilbert space. For non-singular theories, i.e. if the matrix $L_{ij} = \partial^2 L/\partial q^i \partial q^j$ is non singular, this procedure leads to a quantum formulation completely equivalent to that obtained by the usual methods. For singular theories, however, there remain some open questions. P.Roman

530.145

1490. GENERALIZATION OF GAUGE INVARIANCE AND COMBINED INVERSION. V.L.Pokrovskiĭ.
Zh. éksper. teor. Fiz., Vol. 33, No. 1(7), 269-71 (1957). In Russian.

Gauge invariance for a field with several different charge states is considered. The hypothesis of combined inversion proposed by Landau is shown to be equivalent to invariance relative to the generalized gauge transformation with positive Jacobian.

G.E.Brown

530.145

1491. CONSERVATION OF PARITY IN STRONG INTERACTIONS. S.N.Gupta.
Canad. J. Phys., Vol. 35, No. 11, 1309-11 (Nov., 1957).

The conservation of parity in electromagnetic and mesonic interactions and the non-conservation of parity in the neutrino interactions are discussed on the basis of the principle of invariance under combined space inversion and charge conjugation. A.

530.145

1492. PROBLEM OF CONSERVATION OF PARITY IN THE THEORY OF ELEMENTARY PARTICLES.
V.L.Pokrovskiĭ and Yu.B.Rumer.
Zh. éksper. teor. Fiz., Vol. 33, No. 1(7), 277-9 (1957). In Russian.

It is pointed out that a five-dimensional optics developed earlier (Investigations in 5-Optics by Yu.B.Rumer, Moscow: G.T.T.I., 1956) can give a criterion for dividing interactions into parity-conserving (strong) and parity-violating (weak). The emission of a boson by a fermion falls into the former class; the decay of a boson into two fermions, into the latter. G.E.Brown

530.145

1493. A STUDY OF TENSOR FIELDS WITHOUT SUPPLEMENTARY CONDITIONS. Tzou Kuo-Hsein.
Ann. Phys. (Paris), Vol. 2, No. 11-12, 778-826 (Nov.-Dec., 1957). In French.

Tensor fields of general rank may be separated covariantly into states of given total spin by defining their symmetry and requiring that they satisfy certain conditions. For antisymmetric fields, the vanishing of a 4-divergence is sufficient, but symmetric fields also require that a tensor trace vanish. A new method is given for explicit derivation of the equations and of the commutation relations of a field of definite spin, automatically satisfying the subsidiary conditions. It is shown that the divergence condition is equivalent to an irrotational condition on another field. A field of zero bare mass provides an exceptional case. To effect the separation it is necessary to assume a priori that the divergence vanishes. It is shown that, for interactions linear in the field, the decomposition remains valid. For electromagnetic interactions, which are quadratic in the field, a mixing of states of different spin is expected. It is found that certain spin states have negative energy, but it is indicated that this has no physical consequences in processes involving only virtual quanta. G.H.Burkhardt

530.145 : 530.12

1494. QUANTIZATION OF THE INTERACTING FIELDS OF ELECTRONS, ELECTROMAGNETISM AND GRAVITY.
F.J.Belinfante, D.I.Caplan and W.L.Kennedy.
Rev. mod. Phys., Vol. 29, No. 3, 518-46 (July, 1957).

Recent developments in the theory of the quantization of the gravitational field in its interaction with the Maxwell and the Dirac fields are reviewed in a coherent presentation. The topology of the universe is taken to be the simplest one and it is assumed, that all fields drop off to zero sufficiently strongly at spatial infinity, for the existence of a free energy-momentum four vector. In part I, the classical theory of fermions is modernized by replacing the c-number formulation by a "quasi c-number" theory, in which the entities are ordinary c-numbers but for the fact that they flip sign when commuted with another such quantity. The quantization of this theory is then achieved by using some earlier suggestions of Dirac. New variables have to be introduced in place of the original canonical variables derived from the Lagrangian, so as to obtain canonical commutation relations. Then the theory is altered in part II, by adding non-covariant elements, which avoids the difficulties encountered in the proof of covariance of the above quantization procedure. Auxiliary conditions are introduced, which prevent the added terms in the Lagrangian having any effect on predictions of the theory. In part III, some problems related to the "initial value problem" and that of determining the "true variables" of the classical gravitational theory are briefly discussed, together with the question as to whether there exists such a thing as the interaction representation in the general theory of relativity. P.Roman

530.145 : 538.3

1495. ELECTROMAGNETIC MULTIPOLE RADIATION.
R.H.Good, Jr.
Ann. Phys. (New York), Vol. 1, No. 3, 213-20 (June, 1957).

Gives a derivation of the electromagnetic multipole radiation formulae which emphasizes the parallel between the radial problem for photons and the radial problem for Schrödinger or Dirac particles. The Maxwell equations are rewritten in Hamiltonian form, simultaneous eigenfunctions of the square of the angular momentum operator, its z component, and the Hamiltonian are found, and the outgoing waves are selected from these. A.

530.145

1496. PROOF OF THE T.C.P. THEOREM. G.Lüders.
Ann. Phys. (New York), Vol. 2, No. 1, 1-15 (July, 1957).

A comparatively simple proof is given for the general theorem that a wide class of quantized field theories which are invariant under the proper Lorentz group is also invariant with respect to the product of time reversal (T), charge conjugation (C), and parity (P). In the proof use is made of an important simplification introduced by Pauli. A.

530.145

1497. ON THE OPERATORS CHARACTERISING THE INTERNAL DEGREES OF FREEDOM OF THE INTERACTING FIELDS.
I.Białynicki-Birula.
Bull. Acad. Polon. Sci. Cl. 3, Vol. 5, No. 12, 1123-6 (1957).

530.145 : 539.12

1498. μ-MESON DECAY IN THE THEORY OF INDIVIDUAL MASS REVERSAL AND IN THE TWO COMPONENT THEORY OF NEUTRINO. H.Segawa and S.Hori.
Nuovo Cimento, Vol. 6, No. 5, 1230 (Nov., 1957).

The theory of Individual Mass Reversal proposed in an earlier paper (Abstr. 8385/1957) is elaborated for the case of μ-meson decay. It predicts results in accordance with those of the two component theory in certain limits, the principal difference being that the asymmetry parameter $\xi = 1$ and the longitudinal polarization of the electron is complete for all permissible values of the coupling constants. P.K.Kabir

530.145 : 539.12

1499. REMARKS ON THE WEAK LEPTON PROCESSES. K.Senba.
Nuovo Cimento, Vol. 7, No. 4, 429-41 (Feb. 16, 1958).

A tentative model, a modification of Konopinski—Mahmoud's model concerning leptons is developed for the classification of the processes where leptons take part. By means of this model, a good selection rule is obtained, and the redundant neutral particle is not introduced which always appears in the model based on the charge independence hypothesis extended to leptons. The relation between the Gell-Mann—Nishijima model and this scheme is referred to and the interaction structure with the scheme is discussed. Although a good selection rule is obtained for lepton processes, it is concluded that for a classification of leptons, their interaction structure is always to be taken into account. A.

530.145

1500. FURRY'S THEOREM FOR VERY STRONG INTERACTIONS. R.E.Pugh.
Phys. Rev., Vol. 109, No. 3, 989-90 (Feb. 1, 1958).

An analogon to Furry's theorem is proved for Gell-Mann's "globally symmetric" model of very strong interactions. It is shown that the contribution corresponding to a diagram with an odd number of external pion lines and any number of external photon lines vanishes. A.

530.145

1501. TWO-ELECTRON GREEN'S FUNCTION IN THE BLOCH—NORDSIECK APPROXIMATION. R.V.Tevikyan.
Zh. éksper. teor. Fiz., Vol. 32, No. 6, 1573-4 (1957). In Russian.

Green's function is obtained in this case as a two-dimensional integral. G.E.Brown

530.145

1502. GREEN'S FUNCTION IN SCALAR ELECTRODYNAMICS IN THE BLOCH—NORDSIECK APPROXIMATION. R.V.Tevikyan.
Zh. éksper. teor. Fiz., Vol. 32, No. 6, 1575 (1957). In Russian.

Using Fock's method of proper time, the equation can be solved in the no-recoil approximation. The process of production of an arbitrary number of low-energy photons of energy less than ϵ' and n additional photons with energies from E_1 to E_2 is calculated. G.E.Brown

530.145 : 539.12

1503. ON THE MASS SPECTRUM OF ELEMENTARY PARTICLES. R.Reulos.
Arch. Sci. (Geneva), Vol. 10, No. 3, 455-9 (July-Sept., 1957). In French.

530.145

1504. ON THE POLARISATION AND MAGNETIC MOMENT OF SPINOR PARTICLES IN THE QUANTUM FIELD THEORY. I.Białynicki-Birula and Z.Białynicka-Birula.
Bull. Acad. Polon. Sci. Cl. 3, Vol. 5, No. 12, 1119-21 (1957).

530.145

1505. ON SPACE, TIME AND WORLD REVERSALS IN THE THEORY OF DIRAC SPINORS. I. DEFINITION AND FUNDAMENTAL PROPERTIES OF NORMAL REPRESENTATIONS. II. PARTICULAR NORMAL REPRESENTATIONS. THE SIX FUNDAMENTAL REPRESENTATIONS. J.Winogradzki.
C.R. Acad. Sci. (Paris), Vol. 245, No. 22, 1896-8 (Nov. 25); No. 25, 2206-8 (Dec. 16, 1957). In French.

In a study of spinor representations of the general Lorentz group, three types of "normal" representations E, T and U are introduced, associated respectively with the sub-group of spatial rotations and reflections, the sub-group of spatial rotations and time reversals and with the proper Lorentz group. In a normal representation, the 4-spinor (ϕ,Ψ) transforms to $\pm\lambda(\phi, -\Psi)$, where λ is 1 or i, under a reversal characteristic of the representation, but under a non-characteristic reversal each semi-spinor transforms into a function of the other. Particular representations are introduced in which the transformed spinor is of the form $\pm\mu(\Psi, \pm\phi)$ in the case of a non-characteristic reversal, μ being 1 or i. There are two such "fundamental" representations for each of the three types E, T and U of normal representations. R.A.Newing

530.145

1506. THEORY OF THE DIRAC FIELD AS A CONTINUOUS ASSEMBLY OF SMALL ROTATING BODIES. T.Takabayasi.
Nuovo Cimento, Vol. 7, No. 1, 118-21 (Jan. 1, 1958).

530.145

1507. ON THE SYMMETRIES OF THE DIRAC FIELD. H.Rollnik.
Nuovo Cimento, Vol. 7, No. 2, 249-50 (Jan. 16, 1958). In German.

It can be shown that the transformations $\Psi'(x) = A\Psi(Lx) + \bar{\Psi}(Lx)B$ leave the field equations and the commutation relations invariant if $A = \mu\Lambda^{-1}$, $B = \lambda\Lambda C$ or alternatively if $A = \mu C^{-1}\gamma_4\Lambda^{-1}$, $B = \lambda\Lambda\gamma_4$ where Λ is the representation in the space of the Dirac matrices for the inhomogeneous extended Lorentz group L, C is Schwinger's charge-conjugation matrix, and μ, λ complex numbers satisfying $|\mu|^2 + |\lambda|^2 = 1$. The first case applies to a unitary, the second to an antiunitary transformation in Hilbert space. The physical consequences are investigated briefly. P.Roman

530.145

1508. ON THE CREATION OPERATORS OF PHYSICAL PARTICLES. G.Mohan.
Nuovo Cimento, Vol. 7, No. 4, 491-500 (Feb. 16, 1958).

The conventional annihilation and creation operators of free particles are modified in view of the fact that all measurements require non-vanishing duration of time. The modified operators create and annihilate physical particles. Asymptotic assumption or adiabatic hypothesis are not invoked so that the renormalized S-matrix can be obtained without their help. The analysis of certain functions that occur in the definitions of the modified operators is incomplete. A.

530.145

1509. WAVE EQUATION FOR A MASSLESS PARTICLE WITH ARBITRARY SPIN. C.L.Hammer and R.H.Good, Jr.
Phys. Rev., Vol. 108, No. 3, 882-6 (Nov. 1, 1957).

A wave-equation for a noninteracting particle with zero mass and arbitrary spin s is given. The Hamiltonian is proportional to the inner product of the momentum and spin operators so that the wave-function has 2s + 1 components. As an auxiliary condition, solutions with spins not parallel or anti-parallel to the momentum are discarded. With this condition the theory is Lorentz-covariant. The energy, momentum, and angular momentum are defined in terms of expected values of the usual type of displacement operator. The specialization $s = \frac{1}{2}$ is the two-component neutrino theory and $s = 1$ gives Maxwell's equations for the photon. A.

530.145 : 539.14

1510. EXPRESSIONS FOR CERTAIN WIGNER COEFFICIENTS. A.P.Stone.
Proc. Phys. Soc. A, Vol. 70, Pt 12, 908-9 (Dec., 1957).

A simplified summation for the Wigner coefficient $C^{j+s\ j\ J}_{m+\mu\ m\ 2m+\mu}$ is derived, using a closed formula for $C^{j\ j\ j'}_{m\ m\ 2m}$. Explicit expressions are given for $s = \frac{1}{2}$, 1. M.J.Kearsley

530.145

1511. ON THE QUESTION OF A NEUTRINO ANALOG TO ELECTRIC CHARGE. J.Klauder and J.A.Wheeler.
Rev. mod. Phys., Vol. 29, No. 3, 516-17 (July, 1957).

In a multiply connected space there exist zero-frequency solutions of Maxwell's equations, and the number of independent constants (to be identified with charges) is equal to the number of "worm-holes" in the space (Misner and Wheeler, Abstr. 1468/1958). By considering a simple toroidal space, it is shown that the same thing is not true generally of the two-component neutrino equation. It is concluded that "there is no reason to expect for the neutrino field a concept of charge having any direct analogy to electric charge". J.C.Taylor

530.145

1512. ON CONVERGENCE OF THE PERTURBATION SERIES IN THE THEORY WITH A NON-RELATIVISTIC NUCLEON. A.D.Galanin and Yu.N.Lokhov.
Zh. éksper. teor. Fiz., Vol. 33, No. 1(7), 285-6 (1957). In Russian.

From a comparison of the pseudoscalar symmetrical theory with the neutral one, where the solution is known, one can show that the perturbation series in the former case has an infinite radius of convergence. G.E.Brown

530.145

1513. CALCULATION OF SCATTERING FROM A COMPLEX SQUARE WELL BY A VARIATIONAL METHOD. J.Sokoloff and M.Hamermesh.
Ann. Phys. (New York), Vol. 2, No. 2, 157-65 (Aug., 1957).

In the course of numerical calculations of scattering from a complex square well, it was found useful to obtain estimates of phase shifts by quick hand computation. This can be accomplished by a simple variational method. The phase shifts for all angular momenta can be obtained in closed form convenient for computation. A.

530.145

1514. DISPERSION RELATIONS FOR VIRTUAL PROCESSES. A.A.Logunov.
Dokl. Akad. Nauk SSSR, Vol. 117, No. 5, 792-4 (1957). In Russian.

Dispersion relations for vertex parts with one virtual photon or meson are investigated. The antihermitian part of the amplitude for the photocreation of pions by virtual γ-quanta is calculated and it can be shown that the integration interval decomposes into two sections; the first gives a non-vanishing contribution only for one-nucleon states, whereas all other states contribute only to the integral over the second section. It can be seen that the obtained dispersion relations contain parts with unobservable energies. Possible applications are briefly indicated and attention is drawn to the fact that in the one-meson approximation one can express the phases of the vertex photocreation by the phases of the meson–nucleon scattering. P.Roman

530.145 : 539.12

1515. NUCLEON–NUCLEON SCATTERING AT HIGH ENERGY. M.Gourdin.
Nuovo Cimento, Vol. 7, No. 3, 338-64 (Feb. 1, 1958).

Nucleon–nucleon scattering and polarization experiments cannot be explained by a simple local potential. This method gives good results in the low energy domain; but between 0 and 300 MeV, for example, it is well known that the Schrödinger equation is inadequate. It is necessary, at high energies, to use a completely covariant formulation for two body systems — the Bethe and Salpeter equation — in order to take into account relativistic corrections. With an analytical continuation of the scattering amplitude for the imaginary values of relative time (or relative energy), the method of partial waves can be generalized to a four dimensional Euclidian problem. It is shown that, in the simplified case of spinless particles (Klein–Gordon particles), the physical phase-shifts corresponding to a given value of the orbital angular momentum are easily obtained. For the more realistic case of spin $\frac{1}{2}$ particles (Dirac particles) it is possible to calculate the differential cross-section. Explicit solutions are obtained with an approximate method of resolution for the integral equations. Further, one can determine the value of the coupling constant that gives the correct experimental neutron–proton singlet scattering length, in the case of the "ladder approximation". The ^1S phase shift, calculated for various values of the energy, exhibits a change of sign in the energy region of 140 MeV. This result is in agreement with the experiments and the "hard core" theory of Levy. A.

530.145

1516. SCATTERING OF LONGITUDINALLY POLARIZED FERMIONS. A.M.Bincer.
Phys. Rev., Vol. 107, No. 5, 1434-8 (Sept. 1, 1957).

Cross-sections for scattering of longitudinally polarized Dirac particles are calculated. The results are presented in terms of the ratio of cross-sections ϕ_p/ϕ_a. (The cross-section is denoted by ϕ_p when the spins of the particles before scattering are parallel, by ϕ_a when antiparallel). In the case of scattering of indistinguishable particles ϕ_p/ϕ_a is different from unity at all energies and scattering angles and can be as small as zero. For particle–antiparticle scattering ϕ_p/ϕ_a is close to unity at nonrelativistic energies, but at relativistic energies approaches the value of the corresponding ratio for indistinguisable-particle scattering. Thus, in both these cases, the scattering process provides a method for measuring longitudinal polarization. Thirdly, ϕ_p/ϕ_a is calculated for two particles of different masses m and μ. It is shown that also in this case, in principle, ϕ_p/ϕ_a could be used for polarization measurements. A.

530.145 : 539.12

1517. DIFFERENTIAL AND TOTAL CROSS SECTIONS FOR NUCLEON–ANTINUCLEON SCATTERING. F.E.Prieto.
Phys. Rev., Vol. 107, No. 5, 1439-41 (Sept. 1, 1957).

By the use of perturbation theory to the second order, and pseudoscalar meson theory with pseudoscalar coupling, the differential and total cross-sections for the scattering of antinucleons by nucleons are obtained. It is found that the cross-section for charge-annihilation scattering is about 7/3 that for normal scattering, and for both, a decrease of the cross-section with increasing energy is obtained, and for a given energy the cross-section decreases with increasing scattering angle. The results agree in general behaviour and in order of magnitude with the available experimental data. A.

530.145

1518. S-MATRIX FORMALISM FOR LEVEL-SHIFT CALCULATIONS. J.Sucher.
Phys. Rev., Vol. 107, No. 5, 1448-9 (Sept. 1, 1957).

An exact formula for the level shift is given in terms of the adiabatic S-matrix constructed from the perturbation which produces the shift. The formula is used to discuss the role of the subsidiary condition in quantum electrodynamic level-shift calculations. A.

530.145

1519. NONLINEAR COUPLING IN LOW-ENERGY MESON THEORY. L.P.Horwitz.
Phys. Rev., Vol. 108, No. 3, 886-90 (Nov. 1, 1957).

It is shown that a very large class of meson–nucleon interactions leads to the same first-order scattering equations as would be obtained by adding simple nonlinear terms to the familiar linear pseudovector coupling in the Chew–Low–Wick formalism. The class of interactions under consideration is large enough to include what one would expect to be a reasonable form for the nonrelativistic limit of the charge-symmetric pseudoscalar interaction. In the gauge-invariant extension of the theory to photoproduction, the P-wave coupling constant is not exhibited explicitly in the energy-independent S-wave part of the inhomogeneous terms of the integral equation for the transition amplitude. It is shown directly, however, that the contribution of the higher order terms in the limit of zero total energy is exactly as required for the satisfaction of the Kroll–Ruderman theorem. A.

530.145

1520. APPLICATION OF DISPERSION RELATIONS TO S-WAVE MESON–NUCLEON SCATTERING. K.Tanaka.
Phys. Rev., Vol. 108, No. 6, 1629-36 (Dec. 15, 1957).

Relativistic dispersion relations derived by Chew et al. are used to study the energy dependence of the S-wave phase shifts in low-energy meson–nucleon scattering. An S- and P-wave analysis and an S-, P-, and D-wave analysis are carried out under the assumption that the (3,3) resonance dominates the dispersion integral. Taking more accurately into account the recoil effects of the nucleon improves the agreement of the energy dependence of the S-wave phase shifts with experiment. The P-wave scattering lengths are determined numerically. A.

530.145

1521. ASYMPTOTIC EXPANSION FOR HIGH-ENERGY POTENTIAL SCATTERING. J.J.Tiemann.
Phys. Rev., Vol. 109, No. 1, 183-8 (Jan. 1, 1958).

An asymptotic expansion of a previously derived approximate expression for high-energy potential scattering is obtained. This is used to compute numerical values for the large-angle differential scattering cross-section of a Schrödinger particle scattered by a spherically symmetric parabolic potential well and of a relativistic electron scattered by a uniformly charged sphere. In both cases the parameters are such that the Born approximation cannot be used. These values are compared with the results of an exact partial wave calculation and (in the parabolic-well case) with the results of numerical integration of the full approximate expression. The object of this work is to gauge the reliability both of the full approximate expression, and of its asymptotic expansion. It is found that for both the Schrödinger equation and the Dirac equation the locations of the maxima and the minima of the scattering cross-sections are reproduced with good accuracy. The magnitudes of the minima, however, are not given reliably and although the general shapes of the curves are correct, the magnitudes of the maxima differ from the correct values by 10 to 50%, depending on the value of kR. A.

530.145

1522. SIGNIFICANCE OF THE REDUNDANT SOLUTIONS OF THE LOW–WICK EQUATION. R.Norton and A.Klein.
Phys. Rev., Vol. 109, No. 3, 991-5 (Feb. 1, 1958).

The content of the Low–Wick scattering formalism is studied, using the example of a class of exactly soluble meson theories with fixed-source interaction. The theories in question describe a set of harmonic oscillators with an arbitrary distribution of frequencies, coupled to a scalar meson field by means of their total dipole moment. The Low equation for scattering of a meson is shown to possess infinitely many solutions. These are compared with the exact, explicit solution of the same problem, and it is shown that there is a one-to-one correspondence between a particular choice of theory (number of oscillators and their frequencies) and a given one of the aforementioned solutions of the Low equation. A similar situation is shown to obtain for symmetric pseudoscalar theory, and it is made plausible thereby that Chew and Low have chosen the particular solution appropriate to their Hamiltonian. A.

530.145

1523. MESON PAIR THEORY IN INTERMEDIATE COUPLING. R.J.Drachman.
Phys. Rev., Vol. 109, No. 3, 996-8 (Feb. 1, 1958).

Wentzel's scalar meson pair theory is treated in the intermediate coupling approximation, for two different forms of the cutoff function, and for various values of the coupling constant. The agreement of the approximate values of the self-energy with the exact ones is excellent. A.

530.145

1524. AN IMPROVED BORN APPROXIMATION. D.Park.
Proc. Phys. Soc. A, Vol. 70, Pt 12, 905-7 (Dec., 1957).

The first Born approximation for scattering problems is modified to make it unitary and leads to more accurate values for phase-shifts less than about 20^0, but less accurate values above this. As an example, the exact phase-shifts for S-wave scattering by square well potentials of increasing depth are compared with those calculated using the Born approximation and its modification.

M.J.Kearsley

530.145

1525. POSSIBILITY OF CONSTRUCTING A CHAIN OF EQUATIONS FOR THE MODEL OPERATORS. V.M.Eleonskii.
Zh. éksper. teor. Fiz., Vol. 32, No. 6, 1585-7 (1957). In Russian.

A series of equations for reducing the many-body problem to the independent particle one is constructed. G.E.Brown

530.145 : 539.12

1526. APPLICATION OF MATRIX POLYNOMIALS FOR DETERMINATION OF SCATTERING PHASE-SHIFTS. Yu.I.Kulakov.
Zh. éksper. teor. Fiz., Vol. 33, No. 2(8), 501-13 (1957). In Russian.

The formalism of invariant matrix polynomials $L_{l'l;J}^{s's}$ is considered for a system of particles of arbitrary spin. A general method for determination of $L_{l'l;J}^{s's}$ is presented and explicit polynomials for total spins of 0, $\frac{1}{2}$ and 1 are given. Expansion of the invariant operators in terms of polynomials $L_{l'l;J}^{s's}$ can be appreciably simplified by the relations given in the paper. It is shown that the coefficients of the expansion of the scattering matrix in the polynomials $L_{l'l;J}^{s's}$ are related in a simple manner to the proper phase-shifts. Formulae are presented which permit one to compute with any degree of accuracy in perturbation theory the scattering phase-shifts. In some particular cases the described method significantly simplifies evaluation of phase-shifts. A.

530.145 : 539.12

1527. ON GREEN'S FUNCTION OF THE CASCADE KINETIC EQUATIONS. Kh.Ya.Khristov.
Zh. éksper. teor. Fiz., Vol. 33, No. 3(9), 683-95 (1957). In Russian.

A cascade is considered which consists of several types of particles moving in a non-uniform medium whose properties vary with time. These particles collide with the particles of the medium and are scattered, absorbed and produce new cascade particles. Functions are introduced which specify the spatial and velocity distribution of each type of particle at any moment of time. Integral equations for these functions are given. Approximate solutions of these equations are presented which are valid at large values of time and refer to a uniform and time-independent medium. Better solutions are obtained by iteration. A.

530.145

1528. ON THE PRINCIPLE OF LARMOR INVARIANCE. A.A.Borgardt.
Zh. éksper. teor. Fiz., Vol. 33, No. 3(9), 791-2 (1957). In Russian.

In the course of some remarks concerning the author's two earlier papers (Abstr. 9271/1951, 9919/1953) it is shown that the proper Lagrangian of a Larmor-invariant boson field is the sum of a scalar and pseudoscalar term. P.Roman

530.145 : 539.12

1529. EFFECT OF DAMPING ON THE POLARIZATION OF DIRAC PARTICLES IN SCATTERING. A.A.Sokolov and B.K.Kerimov.
Zh. éksper. teor. Fiz., Vol. 33, No. 3(9), 827-9 (1957). In Russian.

The integral equation set up previously by the authors (Abstr. 7607/1957) to investigate the elastic scattering of particles according to the theory of radiation damping is solved to obtain the scattering amplitudes for Dirac particles with polarization on a δ-potential. The cross-sections obtained are analysed for various cases, in particular for double scattering with and without spin-flip. P.Roman

530.145

1530. APPROXIMATIONS FOR COULOMB WAVE FUNCTIONS. R.H.Barlett, M.H.Rice and R.H.Good, Jr.
Ann. Phys. (New York), Vol. 2, No. 4, 372-83 (Oct., 1957).

Gives a discussion of W.K.B.-type approximations to the solutions of the radial wave-equation for a Schrödinger particle in a Coulomb field. Approximations based on Airy integrals, $(L + \frac{1}{2})$-order Bessel functions, and $(2L + 1)$-order Bessel functions are considered. The results indicate that important factors in the choice of the basic function for the approximation are the poles in the effective potential. A.

530.145

1531. SOME NONSEPARABLE BOUNDARY VALUE PROBLEMS AND THE MANY-BODY PROBLEM. L.Eyges.
Ann. Phys. (New York), Vol. 2, No. 2, 101-28 (Aug., 1957).

The quantum-mechanical problem of the motion of N interacting particles, e.g., hard spheres in a box, is a nonseparable boundary value problem in a 3N-dimensional space. The nonseparability is of a special kind in that it involves a number of boundaries, for each of which the wave-equation is separable, but which taken as a whole make up a nonseparable problem. It is then suggestive for the many-body problem to consider analogous nonseparable problems in three dimensions, and a method for treating a rather general class of them is given. This is illustrated by a discussion of the solution of the Helmholtz equation with Dirichlet conditions for a box containing one or more hard spheres. This method also gives the solution to the general problem of multiple scattering by a configuration of scatterers of finite range. The difficulties of using perturbation theory with hard spheres are discussed, and a method is described for getting around these difficulties. This perturbation method is applied to the problem of two hard spheres in a finite box and the energy shift is found to lowest order in hard sphere radius for particles with symmetric and antisymmetric wave-functions. In the light of the above results some qualitative features of the N-body problem are discussed. It is pointed out that the energy perturbation of the ground state of a dilute hard-sphere Bose gas is different for periodic and for Dirichlet boundary conditions and that this is not a surface effect, in the sense that it does not vanish as the volume becomes very large. Finally, a connection is shown between the van der Waals equation and Weyl's theorems on the asymptotic distribution of eigenvalues for the Helmholtz equation. A.

530.145

1532. THE MANY-BODY PROBLEM AND THE BRUECKNER APPROXIMATION. L.S.Rodberg.
Ann. Phys. (New York), Vol. 2, No. 3, 199-25 (Sept., 1957).

The many-body problem has been studied by Brueckner and others using a self-consistent-field approach which includes the effects of two-body correlations. Unlike the older Hartree formulation, this method can be applied to particles which interact through strong, short-range forces. The Brueckner approximation is derived here using the methods of conventional perturbation theory; no previous knowledge of the Brueckner method is assumed. The theory is presented in a form which is suitable for application to finite media. The operator which describes the effective two-body interaction in a many-particle medium is introduced and discussed. The self-consistent potential is obtained; it is shown to minimize corrections to the lowest-order approximation, in which only two-particle correlations are included. The cancellation of higher-order "unlinked clusters" is demonstrated. Finally, a differential formulation of the method is derived. A.

530.145

1533. SCHWINGER'S FUNCTIONAL WITHOUT ANY ANTICOMMUTING EXTERNAL SOURCES. I.Białynicki-Birula.
Bull. Acad. Polon. Sci. Cl. 3, Vol. 5, No. 12, 1127-9 (1957).

Schwinger's theory of Green's functions (Abstr. 64-5/1952) is modified so that "anticommuting c-number" sources need not be considered, but only true c-number sources. J.C.Taylor

530.145

1534. SOME PROPERTIES OF QUANTUM MECHANICAL PROBABILITIES. A.Guichardet.
C.R. Acad. Sci. (Paris), Vol. 245, No. 25, 2211-13 (Dec. 16, 1957). In French.

Some theorems concerning the probability laws associated with the physical magnitudes and quantized states of a system, and the precision of physical measurements. P.M.Davidson

530.145

1535. INVESTIGATION OF A MODEL IN QUANTUM FIELD THEORY. V.G.Solov'ev.
Zh. éksper. teor. Fiz., Vol. 32, No. 5, 1050-7 (1957). In Russian.

A model is considered in which the interaction occurs between spinor and pseudoscalar fields, the classical pseudoscalar field being independent of the coordinates. In virtue of the properties of the model of the equations for Green's function are greatly simplified and this enables one to find their exact solution. An investigation of Green's function of a fermion is carried out. A.

530.145

1536. NOTE ON THE GROUP OF MULTIPLICATIVE RENORMALIZATION IN THE QUANTUM THEORY OF FIELDS. V.Z.Blank, V.L.Bonch-Bruevich and D.V.Shirkov.
Zh. éksper. teor. Fiz., Vol. 33, No. 1(7), 265-6 (1957). In Russian.

The relations of the renormalization group are obtained directly from the complete Green functions, without going into perturbation theory. G.E.Brown

530.145

1537. APPLICATION OF THE HARTREE–FOCK EQUATIONS TO A SYSTEM OF QUASIPARTICLES. V.M.Eleonskiĭ and P.S.Zyryanov.
Zh. éksper. teor. Fiz., Vol. 33, No. 1(7), 289-91 (1957). In Russian.

The Hartree–Fock equations are transformed into a hydrodynamical form. A solution for uniform density is easily found, and for systems in which the density is almost uniform one can obtain a linear equation. G.E.Brown

530.162

1538. ON THE THEORY OF THE DECAY OF QUASI-STATIONARY STATES. L.A.Khalfin.
Dokl. Akad. Nauk SSSR, Vol. 115, No. 2, 277-80 (1957). In Russian.

The formal theory is considered. An expression is derived for the energy distribution function in the state, in terms of the experimental decay probability function, by the use of a dispersion relation. G.H.Burkhardt

530.162

1539. ON THE CALCULATION OF FLUCTUATIONS AND CORRELATIONS BY THE GIBBS METHOD. I.P.Terletskij.
Nuovo Cimento, Vol. 7, No. 3, 308-13 (Feb. 1, 1958).

The exact relations for the calculation of mean square deviations and correlation functions determined both by the fluctuation and the Brownian movement theories are obtained by the Gibbs method of statistical mechanics. A.

530.162 : 536.7

1540. DERIVATION OF THE FLUCTUATION-DISSIPATION THEOREM. K.M.van Vliet.
Phys. Rev., Vol. 109, No. 4, 1021-2 (Feb. 15, 1958).

A simple derivation is given of the fluctuation-dissipation theorem or generalized Nyquist formula. The proof is based on a solution of the Langevin equation for a thermodynamic variable according to Ornstein's method; in this way the correlation function and the spectrum are obtained directly in the desired form. A.

530.162

1541. COVARIANT QUANTUM STATISTICS OF FIELDS. A.O.Barut.
Phys. Rev., Vol. 109, No. 4, 1376-80 (Feb. 15, 1958).

Relativistic formulae are derived for energy, momentum and number densities and distributions for systems of bosons and fermions from a covariant formulation of the statistics of fields. Charge, spin, and angular momentum statistics are discussed. A.

530.162

1542. EQUATIONS WITH VARIATIONAL DERIVATIVES IN STATISTICAL EQUILIBRIUM THEORY. I.P.Bazarov.
Zh. éksper. teor. Fiz., Vol. 32, No. 5, 1065-77 (1957). In Russian.

Equations with variational derivatives for correlation (correlative distribution) functions were deduced. A method was developed for solving these equations for various systems in statistical equilibrium. An "addition theorem" for determination of the correlation (correlative distribution) functions is established for the case when the interaction between particles of the system can be described as the sum of long- and short-range forces. A.

GENERAL MECHANICS. MECHANICS OF SOLIDS

531.31 : 531.51

1543. ON THE DEPENDENCE OF THE MOTION OF BODIES IN A GRAVITATIONAL FIELD ON THEIR MASS. I.G.Fikhtengol'ts.
Zh. éksper. teor. Fiz., Vol. 32, No. 5, 1098-101 (1957). In Russian.

The Lagrangian of the equations of motion of a small-mass body in the fixed field of n other finite masses is derived in a second approximation in gravitation theory. This function is compared with the Lagrangian of the equations of motion of a finite mass in the gravitational field of all n + 1 bodies. It is found that in the approximation considered the Langrangian for the motion of a finite mass depends essentially on the value of this mass. A.

MECHANICAL MEASUREMENTS

531.711 : 535.331

1544. OPTICAL DEFINITION OF THE METRE. H.Barrell.
Nature (London), Vol. 180, 1387-8 (Dec. 21, 1957).

The Comite Consultatif pour la Définition du Mètre has recommended that the metre should be defined as equal to 1 650 763.73 times the wavelength in vacuo of the orange–red radiation $2p_{10}$–$5d_5$ of the Kr^{86} atom. The background to this recommendation is explained and it is stated that with a suitable source, the new definition is reproducible to within 3 parts in 10^9. A.H.Cook

531.787.2

1545. A PRECISION CAPSULE-TYPE PRESSURE GAUGE FOR THE RANGE 0-20 mm OF MERCURY. R.W.Crompton and M.T.Elford.
J. sci. Instrum., Vol. 34, No. 10, 405-7 (Oct., 1957).

The construction and calibration of a capsule-type pressure gauge for the range 0-20 mm of mercury is described. Incorporating both mechanical and optical amplification of the capsule movement, the gauge is direct-reading and independent of the nature of the gas under pressure. Sources of error in construction and calibration are examined and an accuracy of better than 1% at 1 mm of mercury and 0.1% at 20 mm of mercury is shown to be obtained. A.

531.787.6

1546. DESCRIPTION OF A SENSITIVE MICROMANOMETER. R.Eichhorn and T.F.Irvine, Jr.
Rev. sci. Instrum., Vol. 29, No. 1, 23-7 (Jan., 1958).

A micromanometer is described for the measurement of differential pressures greater than 10^{-4} in. of water with tolerable accuracy. The instrument uses concentric tubes to form the fluid passages and provides for remote indication of the level in the central tube by means of a mirrored float and telescope and scale arrangement. The highest instrument sensitivity obtained was 3.15×10^{-5} in. of water applied pressure per mm of scale reading, but with suitable refinement in the optical system, it is felt that greater sensitivities are possible. A.

MECHANICS OF FLUIDS

532.133 : 532.77

1547. VISCOSITY OF DILUTE SOLUTIONS OF LONG CHAIN POLYMER MOLECULES. H.L.Bhatnagar, A.B.Biswas and M.K.Gharpurey.
J. chem. Phys., Vol. 28, No. 1, 88-90 (Jan., 1958).

An expression for the relative viscosity η_r is obtained on the basis of the "theory of rate processes" using an "equivalent sphere" model, which relates η_r to parameters such as the shearing force, absolute temperature, and the volume fraction of the polymer. In the limit of zero rate of shear, a relation between the Flory constant ϕ and Huggin's constant k" is obtained. Some important applications of the derived equations are discussed. A.

532.61.08

1548. APPARATUS FOR MEASURING VERY LOW INTERFACIAL TENSIONS. H.Y.Jennings, Jr.
Rev. sci. Instrum., Vol. 28, No. 10, 774-7 (Oct., 1957).

A pendent-drop apparatus for rapidly measuring very low interfacial tensions is described. Interfacial tensions as low as 0.001 d/cm were measured at 25°C in a water—oil system. These measurements were made possible through the combined use of small drop-forming tips, long working distance objectives, electronic-flash illumination and Polaroid film. Examples of measurements on water—oil systems are given. The apparatus is designed to provide interfacial tension data as a function of temperature. In addition, the method permits the measurement of interfacial tension as a function of the age of the interface. A.

532.612.4 : 541.183.022

1549. THEORETICAL DERIVATION OF TRAUBE'S RULE. R.H.Aranow and L.Witten.
J. chem. Phys., Vol. 28, No. 3, 405-9 (March, 1958).

A theoretical derivation of Traube's rule for the surface tension of dilute aqueous solutions of homologous series of long chain compounds is given. It is demonstrated that a quantitative interpretation of the rule requires that the molecules of the chain extend randomly upward out of the surface and permit hindered rotations of the CH_2 groups about each carbon—carbon bond. It is shown that the old arguments for supposing that the molecules of the chain lie parallel to the surface of dilute solutions are unconvincing. A.

532.612.4 : 536.632 : 536.753

1550. DETERMINATION OF THE SURFACE TENSIONS OF MOLTEN LEAD, TIN, AND INDIUM BY AN IMPROVED CAPILLARY METHOD. D.A.Melford and T.P.Hoar.
J. Inst. Metals, Vol. 24, Pt 5, 197-205 (Jan., 1957).

An improved capillary method for the measurement of the surface tension of molten metals up to about 1000°C is described. Molten metal is forced by measured differential gas (hydrogen) pressure to equivalent levels in two fused silica capillaries of different bore. The contact angle θ is not simultaneously determined, but by other measurements is shown to be $> 170^\circ$ for lead, tin, and indium, so that $\cos\theta$ may be taken as -1 with little error. An analysis of the errors of the method is given in an appendix. The surface tension γ of lead, tin, and indium at temperature $T^\circ K$ from the melting point to a few hundred °C above it, as determined by the method, are given by

$$\gamma_{Pb} = 624 - 0.24T \text{ dynes/cm}, \quad \gamma_{Pb}(327^\circ C) = 480 \text{ dynes/cm},$$
$$\gamma_{Sn} = 599 - 0.065T \text{ dynes/cm}, \quad \gamma_{Sn}(232^\circ C) = 566 \text{ dynes/cm},$$
$$\gamma_{In} = 602 - 0.10T \text{ dynes/cm}, \quad \gamma_{In}(156^\circ C) = 559 \text{ dynes/cm}.$$

These values are critically compared with previous experimental and estimated values. The results lead to molar surface enthalpies (assuming the surface to be a monolayer of atoms) of about 9600 cal for lead, 8500 for tin, and 8300 for indium, and molar surface entropies of, respectively, about 3.3, 0.4, and 0.8 cal/°K; these values are slightly temperature dependent, leading to positive values of the molar surface heat capacity in each case. They are compared to bulk thermodynamic magnitudes in a discussion of surface bonding and mobility. A.

MOLECULAR THEORY OF LIQUIDS

532.77

1551. MAGNETIC RELAXATION SPECTROSCOPY WITH IONIC SOLUTIONS. S.Broersma.
J. chem. Phys., Vol. 27, No. 2, 481-6 (Aug., 1957).

When the protons in a liquid are subjected to varying magnetic interactions, and a rapid averaging is prevented, it is possible to distinguish liquid elements, chemically similar, but differing in the amount of relaxation $\int_o^t dt'/T$. The customary a.c. modulation of the magnetic field produces the required transient conditions. The phenomena of line broadening, line shift, and reversal of magnetization with time help to recognize the phases. The signal of the weak relaxation phase can easily be diminished by inducing eddy currents in the magnet iron. Additional non-uniformities can be made in water by introducing dia- or para-magnetic ions. An analysis of the processes of relaxation and adsorption shows that these water molecules or protons prevail in the observation for which the time of adsorption is close to the local relaxation time. The transient rate of relaxation of the entire sample is approximately equal to this rate of adsorption, and to the sweep frequency at which the magnetizations of the phases balance. The life-time found for the protons in the inner layer of water surrounding trivalent ions, by studying concentrated diamagnetic solutions, is about 10 msec. For dilute paramagnetic solutions the values range from 300 to one microsecond, decreasing with the distance to the ion, increasing its magnetic moment. The activation energy involved times the power of its dependence upon the distance to the centre ion, is 20 kcal/mole. The effective size of the atmosphere changes from one or two layers for dilute to two or three layers for concentrated solutions. Ice crystals with four layers radius and five milliseconds life-time show up. A.

532.781

1552. HETEROPHASE FLUCTUATIONS NEAR THE FREEZING POINT. S.J.Lukasik.
J. chem. Phys., Vol. 27, No. 2, 523-7 (Aug., 1957).

Numerical calculations of the magnitude of the effects caused by heterophase fluctuations predicted by Frenkel to occur near a first-order phase change are presented for o-cresol and benzene near their freezing point. The magnitude of the effect depends inversely on the number of degrees that the temperature is above the freezing point, the solid—liquid surface energy, and a parameter g_o that is related to the size of the regions in which pre-transition phase changes occur. Appropriate values of the parameters in the theory are discussed and compared with experimental information where possible. A.

532.783

1553. ON THE ATOMIC MOTIONS IN QUASI-CRYSTALLINE ARGON. V.Nardi.
Nuovo Cimento, Vol. 7, No. 4, 545-51 (Feb. 16, 1958).

The direct exchange-energy E of the two atoms in the quasi-crystalline picture of liquid argon is calculated. The result is $E_{evap}/E \cong 1.4$. It is shown that the atomic motions in the liquid, enhanced with respect to the solid by the mutual correlations, can explain the differences experimentally determined in the structure of the two states. A.

MECHANICS OF GASES

533.2

1554. SEALS FOR PRESSURES TO 10000 ATMOSPHERES. W.B.Daniels and A.A.Hruschka.
Rev. sci. Instrum., Vol. 28, No. 12, 1058-9 (Dec., 1957).

The use of "armoured" O-ring seals is discussed. In addition, a simple high-pressure pump piston seal and a proprietary surface treatment to reduce liability of galling of steel parts are described. A.

533.59

1555. A MERCURY-IN-GLASS GAS BURETTE. H.A.Wyllie.
J. sci. Instrum., Vol. 34, No. 10, 410 (Oct., 1957).

Apparatus is described for transferring increments of gas at low pressures from one section to another of a vacuum system. The measurement of the volume of the gas and the operation of transferring it involve its coming into contact with glass and mercury only. A.

MOLECULAR THEORY OF GASES

533.7

1556. SYMMETRY EFFECTS IN GAS KINETICS. II. ORTHO- AND PARA-HYDROGEN.
R.A.Buckingham, A.R.Davies and D.C.Gilles.
Proc. Phys. Soc., Vol. 71, Pt 3, 457-69 (March, 1958).

For Pt I see Abstr. 6811 (1955). The Manchester University Mk I computer was used to calculate accurately the viscosity cross-section for hydrogen molecules, and its dependence on the symmetry of the wave-function for binary collisions. The calculations assume a central intermolecular potential of (exp, 6, 8) type, and cover reduced temperatures in the range $0.05 \leq T^* \leq 2.0$. Comparison is made with estimates of the relative difference in viscosity cross-sections for para-para and para-ortho collisions derived from Becker and Stehl's measurements (Abstr. 4633/1953). Assuming elastic collisions only, fairly good agreement is found at 15°K, but at higher temperatures the theoretical results become increasingly

too small. A central interaction is seemingly inadequate to explain the relatively large ortho-ortho cross-sections observed; in this connection the effect of an increased range of interaction is briefly discussed and shown to be unimportant. A.

533.73

1557. FREE ENERGY FUNCTIONS FOR 54 GASEOUS ELEMENTS. H.G.Kolsky, R.M.Gilmer and P.W.Gilles.
J. chem. Phys., Vol. 27, No. 2, 494-5 (Aug., 1957).

Tables of the free energy functions for 54 elements, each considered as an ideal monatomic gas, were calculated using an I.B.M. 704 computer for the temperature range 0 to 8000° K. A.

VIBRATIONS. ACOUSTICS

534.01

1558. USE OF FOUR-POLE PARAMETERS IN VIBRATION CALCULATIONS. C.T.Molloy.
J. Acoust. Soc. Amer., Vol. 29, No. 7, 842-53 (July, 1957).

Linear elastic systems which have a single input point and a single output point can be characterized by a pair of simple linear equations, namely,

$$F_{input} = \alpha_{11}F_{output} + \alpha_{12}V_{output},$$
$$V_{input} = \alpha_{21}F_{output} + \alpha_{22}V_{output},$$

where the F's are forces, the V's are velocities, and the α's are the four-pole parameters for the system. The use of four-pole parameters permits combinations of mechanical elements to be handled as a single entity, and, as the parameters belong only to the elastic system for which they are defined, they do not depend upon what precedes that particular system or follows it in a mechanical network. This permits the statement of results in a rather general form. These parameters have been used for many years in the analysis of electrical circuits, and it is the purpose of this paper to show their utility in the field of mechanical vibrations. In particular, the four-pole parameters for the basic mechanical elements of mass, spring, and resistance, are obtained. Also, a description of mechanical sources is given. The rules for the connection of four poles and a method of experimentally measuring four-pole parameters is presented. A few specific problems illustrating the use of four poles is set forth, namely: a generalized vibration isolation problem, the response of an elastically mounted mass on an electrodynamic shake table, shock excitation analysis, and some distributed parameter systems (i.e., helical springs and rubber in shear). A.

534.2

1559. EFFECT OF HEAT RADIATION ON SOUND PROPAGATION IN GASES. P.W.Smith,Jr.
J. Acoust. Soc. Amer., Vol. 29, No. 6, 693-8 (June, 1957).

The effect is re-examined after considerable modification of the classical analysis. Account is taken of the fact that a gas radiates energy of given electromagnetic wavelength in proportion to its corresponding coefficient of absorption, which is a strongly varying function of wavelength with a number of isolated peaks. No restriction is placed upon the value of the electromagnetic absorption per acoustic wavelength. The results indicate that the acoustic attenuation, which generally increases with decreasing frequency, will show a plateau or very flat peak near those frequencies at which one of the peaks of electromagnetic absorption reaches a value of 4π nepers per acoustic wavelength. An upper bound for the effect shows that dispersion and attenuation will be negligible at all frequencies for gases at atmospheric pressure and room temperature, but may become significant in rarified gases or at elevated temperatures. A.

534.22/.23 : 539.374

1560. FREQUENCY DEPENDENCE OF ULTRASONIC ATTENUATION AND VELOCITY ON PLASTIC DEFORMATION. A.Hikata and R.Truell.
J. appl. Phys., Vol. 28, No. 5, 522-3 (May, 1957).

The dependence of ultrasonic attenuation and velocity on plastic deformation in 2S aluminium is compared at two frequencies, 5 and 10 Mc/s, and the comparison shows agreement as regards frequency dependence with what one can expect from dislocation damping theory. A.

534.22

1561. DISPERSION OF PROPAGATION VELOCITY OF ULTRASOUND IN PROPIONIC ACID. A.Barone, G.Pisent and D.Sette.
Nuovo Cimento, Vol. 7, No. 3, 365-70 (Feb. 1, 1958). In Italian.

This was studied between 2 and 6 Mc/s in the temperature range 15-30°C. The results agree with theoretical expectations based on absorption-coefficient data. A.

534.222 : 538.566

1562. FIELD SHOCK WAVES AND THEIR CUMULATION. E.I.Zababakhin and M.N.Nechaev.
Zh. éksper. teor. Fiz., Vol. 33, No. 2(8), 442-50 (1957). In Russian.

For electromagnetic waves with a narrow transition region between initial and final states, a cylindrical converging wave is considered. It is found that as the wave converges its amplitude infinitely increases and a qualitatively new cumulation phenomenon emerges — the appearance of infinitely strong fields in the front of a wave which is reflected from the axis of the wave cylinder, at finite distances from that axis. This phenomenon is not specific for electromagnetism but is inherent in the (cylindrical) geometry of the waves. Acoustic waves possess the same property, but in their case the solution is valid only for weak waves, whereas this restriction does not apply to electromagnetic waves. A.

534.222

1563. CYLINDRICAL SELF-SIMILAR [AVTOMODEL'NYE] ACOUSTIC WAVES. Ya.B.Zel'dovich.
Zh. éksper. teor. Fiz., Vol. 33, No. 3(9), 700-5 (1957). In Russian.

A family of exact solutions is obtained for cylindrical motion in the acoustic approximation which depends on a single parameter. It is obtained by superposition of plane waves and can be expressed in an elementary form by quadratures. In the course of time these solutions transform retaining similitude (automodel solutions). Results, which are identical with those of the preceding abstract, were obtained for motion involving a finite pressure discontinuity on the front of the converging cylindrical wave. It is confirmed that the pressure in the reflected wave is infinite at finite distance from the centre. The maximal pressure is estimated by taking into account deviations from the acoustical approximation at large wave amplitudes. A.

534.222.1 : 536.48

1564. PROPAGATION OF SOUND ACROSS A BOUNDARY BETWEEN TWO SUPERFLUID PHASES. R.G.Arkhipov and I.M.Khalatnikov.
Zh. éksper. teor. Fiz., Vol. 33, No. 3(9), 758-64 (1957). In Russian.

The passage for first and second sound through a boundary between two superfluid liquids is considered. It is found that one type of sound vibrations can change into the other (conversion). Formulae are given for the energy fluxes in the reflected, refracted and converted waves. The case when one of the liquids is not superfluid is considered separately. A.

534.23

1565. THE TRANSMISSION OF A SPHERICAL SOUND WAVE THROUGH A THIN ELASTIC PLATE. G.L.Lamb,Jr.
Ann. Phys. (New York), Vol. 1, No. 3, 233-46 (June, 1957).

The transmission of a spherical sound wave through a thin elastic plate of infinite extent is investigated theoretically. The case considered in detail is that for which the velocity of sound in the surrounding medium is less than the velocity of the free flexural waves in the plate at the frequency of the incident wave. This situation gives rise to considerable radiation into the region on the opposite side of the plate from the incident wave. An integral representation for the transmitted sound field is initially derived and the path of integration subsequently transformed into the complex plane where the integration is then carried out in an approximate manner by means of the method of stationary phase. It is found that the transmitted sound field at any point may be decomposed into three parts; an outgoing spherical wave modified by an amplitude factor containing angular dependence and two "surface waves". The nonradiating case where the velocity of sound in the surrounding medium is greater than the velocity of the flexural waves in the plate is also briefly discussed. A.

534.23

1566. PROPERTIES OF SANDWICH-TYPE STRUCTURES AS ACOUSTIC WINDOWS. J.S.Hickman, D.E.Risty and E.S.Stewart.
J. Acoust. Soc. Amer., Vol. 29, No. 7, 858-64 (July, 1957).

The acoustic transmission of a sandwich consisting of a pair of plane parallel solid plates immersed in a liquid has been investigated theoretically and experimentally. Not only the dilatational waves,

but also the shear waves, are considered. Results show greatly improved transmission characteristics over those of single thick metal plates with respect to dependence on both frequency and angle of incidence. Theoretical transmission curves for a sandwich of two steel plates have been prepared to exhibit the dependence of transmission on frequency, on ratio of plate thickness to wavelength and separation to wavelength, and on angle of incidence, respectively. Calculated transmission curves for single steel plates, including half-wave plates, are shown for comparison. An experimental test was made on a steel sandwich with lateral dimensions of the order of two wavelengths and plate thickness-to-wavelength (in the steel) ratio equal to 0.05. The measured transmission losses are within ±4 dB of the calculated values. A.

534.23 : 532.74

1567. ON THE ORIGIN OF THE ULTRASONIC ABSORPTION IN LIQUIDS. III. K.F.Herzfeld.
J. Acoust. Soc. Amer., Vol. 29, No. 11, 1180-1 (Nov., 1957).

For Pt II, see Abstr. 2518 (1952). In "Kneser" liquids the mechanism of excess ultrasonic absorption is the slow exchange of energy between internal and external degrees of freedom, just as in gases. Eight such liquids are selected; in two the relaxation time in the liquid is known from measurements, in the others it is calculated from low-frequency absorption. In comparing the relaxation time for the liquids with that in the vapour of the same substances, the latter is found to be 100 to 600 times that in the liquid. This is related to the ratio of the collision times. A.

534.231.3

1568. RADIATION IMPEDANCE OF A CYLINDRICAL BORE IN A SOLID. R.M.White.
J. Acoust. Soc. Amer., Vol. 29, No. 6, 751-2 (June, 1957).

It is shown that for the appearance of a zero in the radiation reactance at the wall of a cavity in a solid the same restrictions on Poisson's ratio apply whether the cavity be spherical or circular cylindrical in shape. A.

534.232

1569. PERFORMANCE OF MAGNETOSTRICTIVE TRANSDUCERS MADE OF ALUMINUM–IRON ALLOY OR NICKEL–COPPER FERRITE. Y.Kikuchi.
J. Acoust. Soc. Amer., Vol. 29, No. 5, 569-73 (May, 1957).

A brief history of the finding and development of aluminum–iron alloy introduces the description of an industrial specification. The description covers the specification for the melting and rolling processes, both of which are main factors affecting the magnetostriction characteristics. Improvement of transduction efficiency is then discussed in general, and it is concluded that no other material which has larger coupling factor than that of nickel, or "Alfer", (i.e., the 13.5% aluminum–iron alloy), is necessary, in so far as the transducers to be used at their resonance are concerned. Improvement in the efficiency can be attained only by the considerable elimination of the eddy current, and this is accomplished in several magnetostrictive transducers made of Ni–Cu ferrites which are shown to be excellent for generating underwater ultrasound. Electroacoustic efficiency is as high as 90% even at such higher frequencies as 70 and 100 kc/s. Intense generation of ultrasonic waves is successfully carried on up to the rate of 3 W/cm^2 of the radiation surface. A.

534.232

1570. DESIGN OF A STANDARD SOUND SOURCE.
T.Hayasaka, K.Ikegaya and S.Ishii.
J. Inst. Elect. Commun. Engrs Japan, Vol. 40, No. 11, 1157-64 (Nov., 1957). In Japanese.

The free-field frequency characteristics of a standard sound source are investigated by analysing the sound fields produced by vibrating spheres and by a system consisting of a convex plate, supported by flexible rings for mass control, vibrating as a piston in an infinite baffle. The design of a system of this type, but with a finite baffle, is described and the effect of the size of the baffle used is investigated. A.Wilkinson

534.3

1571. PHYSICAL BASIS OF PIANO TOUCH. J.G.Báron.
J. Acoust. Soc. Amer., Vol. 30, No. 2, 151-2 (Feb., 1958).

The author seeks to show that piano tone is comprised of not only the frequencies produced by the impact of the hammer on the string but, in addition, sundry "noises" caused by, for example, interaction between parts of the mechanism, the impact of the finger on the key and so on. This "noise" element plays an important part and is within the control of the player, being, in fact, what the musician means by "touch". J.B.Arthur

534.321.7 : 621.373.42

1572. AN ELECTRONIC INSTRUMENT FOR TUNING LARGE ORCHESTRAS. M.Caciotti, P.Righini and V.Savelli.
Ann. Télécomm., Vol. 12, No. 10, 367-71 (Oct., 1957). In French.

An electronic device consisting of 6 oscillators tuned to 174.61, 220, 233.44, 293.66, 349.22 and 440 c/s with the necessary power amplifier and supply unit. These oscillators are not pure tones but are copies of recorded tones characteristic of the group of instruments to be tuned. Three equipments have been used with complete satisfaction. Oscillograms and a circuit of the oscillators are given. B.B.Austin

534.322

1573. ON THE INTERPRETATION OF CERTAIN SOUND SPECTRA OF MUSICAL INSTRUMENTS. R.W.Young and H.K.Dunn.
J. Acoust. Soc. Amer., Vol. 29, No. 10, 1070-3 (Oct., 1957).

The problem of computing sound power from measurements of average rectified sound pressure is reviewed, particularly in relation to "Absolute Amplitudes and Spectra of Certain Musical Instruments and Orchestras" a paper published by Sivian, Dunn, and White in 1931. Experimental data on the distribution of instantaneous pressure amplitudes of music in a wide band and relations between r.m.s. and average pressure in octave and half-octave bands for speech are introduced; these data suggest, for example, that in a half-octave band in the vicinity of 1000 c/s the r.m.s. sound-pressure level during a 15 sec interval of music exceeds the average pressure level by 9 dB. Means are described for converting the old data based on "pressure per cycle" to a form that would be obtained with the modern octave band analyser and sound level meter. In place of the steeply sloping spectra suggested by the original figures, the two kinds of corrections lead to an average sound power spectrum, for the 15-piece orchestra, having a broad peak between 100 and 4000 c/s. A.

534.7

PHYSIOLOGICAL ACOUSTICS. HEARING. See also under "Medical science. Human physiology". Decimal classification 612.85

534.781

1574. FACTORAL ANALYSIS OF THE DELAYED SPEECH FEEDBACK PHENOMENON. R.A.Butler and F.T.Galloway.
J. Acoust. Soc. Amer., Vol. 29, No. 5, 632-5 (May, 1957).

Two experiments, employing a total of 388 subjects, were conducted to further study factors influencing performance on the delayed speech feedback task. The rate of presenting reading material, the intensity, and length of delay of speech feedback served as independent variables. A linear relation was found between performance on the feedback task and intensity of the delayed signal. There was an interaction between intensity and delay time of the speech feedback, clearly demonstrating that various delays are differentially effective only at high intensity levels. That the role of delay is more than a simple interference factor produced by background noise was also demonstrated. A.

534.781

1575. COMMENT ON EGAN'S "REMARKS ON RARE PB WORDS". M.R.Rosenzweig.
J. Acoust. Soc. Amer., Vol. 29, No. 12, 1374 (Dec., 1957).
See Abstr. 8492 (1957).

534.782

1576. DYNAMIC ANALOG SPEECH SYNTHESIZER. G.Rosen.
J. Acoust. Soc. Amer., Vol. 30, No. 3, 201-9 (March, 1958).

A dynamically controllable electrical analog of the vocal tract capable of synthesizing sequences of speech sounds is described. The acoustic transmission line between the glottis and lips in the human vocal tract is realized electrically by eleven electronically controlled variable LC sections plus three fixed sections. Each variable capacitor is realized by means of the Miller effect, and the inductors are saturable reactors. Both elements of each section are controlled by a single voltage in a manner that constrains the LC product to remain constant, and varies the ratio L/C to simulate changes in effective cross-sectional area. The analogue can be excited by a buzz source to simulate the glottal tone, by a noise source inserted at various distances from the glottis to simulate the noise of turbulence, or by both together. Thus, vowels and most consonants can be produced with equal facility by the dynamic analogue. Control voltages are derived from a resistance network in which a series of desired articulatory configurations is stored. A timing arrangement chooses the excitation and articulatory configurations in the proper sequence, and smoothing circuits are used to assure natural transitions from one configuration to the next. A.

534.83

1577. NONLINEAR RESPONSE OF AIRCRAFT PANELS IN ACOUSTIC NOISE. E.J.Kirchman and J.E.Greenspon.
J. Acoust. Soc. Amer., Vol. 29, No. 7, 854-7 (July, 1957).

Considers the response of thin elastic plates to sinusoidal acoustic excitation. A theoretical method for obtaining the dynamic deflection and stress in the nonlinear region is given. The theory is compared with test results showing rather good agreement. The application of the theory to the design of panels to withstand acoustic fatigue is discussed in the latter part of the paper. A.

534.831 : 612.8

EFFECT OF ACOUSTIC NOISE ON ALERTNESS OF HUMANS. See Abstr. 1386

534.831 : 612.85

HEARING LOSS DUE TO HIGH NOISE LEVELS. See Abstr. 1399-400

534.835

1578. NOISE SHIELD FOR MICROPHONES USED IN NOISY LOCATIONS. M.E.Hawley.
J. Acoust. Soc. Amer., Vol. 30, No. 3, 188-90 (March, 1958).

A rubber noise shield was developed which significantly improves the speech-to-noise ratio at a military microphone. The construction and evaluation techniques are described, and the advantage of introducing acoustic damping material is shown. A.

534.837

1579. COMPARISON OF THE TAKE-OFF NOISE CHARACTERISTICS OF THE CARAVELLE JET AIRLINER AND OF CONVENTIONAL PROPELLER-DRIVEN AIRLINERS. L.N.Miller and L.L.Beranek.
J. Acoust. Soc. Amer., Vol. 29, No. 11, 1169-79 (Nov., 1957).

Based upon earlier published information concerning the factors that influence neighbourhood response to noise exposure, it is assumed that there are three principal characteristics of noise which must be considered in comparing community response to jet take-offs with that due to propeller aircraft take-offs. These three noise factors are: (1) relative noise levels; (2) duration of noise; and (3) frequency distribution of noise. This paper is devoted to a comparison of the noise produced by the French jet aircraft, the Caravelle, with that produced by conventional propeller-driven airliners in terms of these three factors. Noise level measurements were made under the take-off path at various distances from the beginning of the take-off runway. The conclusion is drawn that the comparative noise levels of the Carvelle, when considered in terms of probable response of listeners to the spectrum distribution of the noise, are approximately equal to those of large propeller aircraft for similar climb rates when heard out-of-doors. Second, the Caravelle noise levels, based on relative listener response, are somewhat lower than those of propeller aircraft when heard in-doors or when the Caravelle is permitted to take off under steep climb conditions. Third, the Caravelle noise persists for longer time intervals than does propeller aircraft noise by a factor of between 1.5 and 3.5, depending upon the distance from the runway. A.

534.84

1580. APPLICATIONS OF THE MONTE CARLO METHOD TO ARCHITECTURAL ACOUSTICS. J.C.Allred and A.Newhouse.
J. Acoust. Soc. Amer., Vol. 30, No. 1, 1-3 (Jan., 1958).

The Monte Carlo method of numerical analysis is applied to the determination of mean free paths and acoustic weighting factors relating probability of collision with walls in rectangular parallelopipeds. The method of calculation is discussed and its extension to determination of reverberation times in coupled rooms and auditoria is evaluated. Tables of relative wall collision probabilities are given for rectangular parallelopipeds of various proportions. A.

534.844.1

1581. DESIGN AND PERFORMANCE OF A NEW REVERBERATION ROOM AT ARMOUR RESEARCH FOUNDATION, CHICAGO, ILLINOIS. D.R.McAuliffe.
J. Acoust. Soc. Amer., Vol. 29, No. 12, 1270-3 (Dec., 1957).

The room has a volume of approximately 3000 ft^3 and a reverberation time of about 5 sec. The four walls and ceiling of the room are splayed. Measurements indicate that the room has a relatively uniform reverberation time with respect to frequency. Data are presented to show the ambient noise level in the room, the steady-state sound energy distribution within the room, and the reverberation time as a function of frequency and location within the room. A.

OPTICS. RADIATION. SPECTRA

535.2

1582. ON AN APPROXIMATION TO SINUSOIDAL MODULATION. R.B.McQuistan.
J. Opt. Soc. Amer., Vol. 48, No. 1, 63-6 (Jan., 1958).

The distribution of modulation frequencies for radiation chopped by passing rectangular chopper teeth over a circular aperture is determined. The ratio of aperture radius to tooth width that produces an amplitude of the fundamental equal to the amplitude obtained in the case of sinusoidally modulated radiation is calculated. The calculation reported also establishes the ratio of aperture radius to tooth width that will result in an r.m.s. value of the incident radiation which is equal to that of sinusoidally modulated radiation. A.

535.31 : 535.4

1583. ON A COMPARISON BETWEEN WAVE OPTICS AND GEOMETRICAL OPTICS BY USING FOURIER ANALYSIS. I. GENERAL THEORY. K.Miyamoto.
J. Opt. Soc. Amer., Vol. 48, No. 1, 57-63 (Jan., 1958).

The geometric optical intensity distribution of light in the point image $I_g(x,y)$ is expressed by

$$I_g(x,y) = a^{-1}\left|\frac{\partial^2\phi}{\partial u^2}\frac{\partial^2\phi}{\partial v^2} - \left(\frac{\partial^2\phi}{\partial u\,\partial v}\right)^2\right|^{-1},$$

where $\phi(u,v)$ is the aberration function and (x,y), (u,v) are the normalized corordinates in the image plane and the exit pupil, respectively, a being the area of the (u,v) region. Hereupon the geometric optical response function $R_g(s,t)$ is given by the Fourier transform of $I_g(x,y)$, that is:

$$R_g(s,t) = a^{-1}\iint_A \exp\left[-2\pi i\left(s\frac{\partial}{\partial u} + t\frac{\partial}{\partial v}\right)\phi\right]dudv,$$

where (s,t) are the normalized line frequencies. The the foregoing formula for $R_g(s,t)$ is compared with the wave optical response function which H.H.Hopkins has deduced, and it is shown that, when the magnitude of the aberration function $\phi(u,v)$ is small compared with the wavelength, the wave optical intensity distribution $I_W(x,y)$ can be expressed approximately by the convolution of $I_g(x,y)$ and the intensity distribution of the aberration-free diffraction image, and when the magnitude of $\phi(u,v)$ becomes large compared with the wavelength, $I_W(x,y)$ is given approximately by $I_g(x,y)$, if $I_g(x,y)$ does not become infinite at any point. In the case where $I_g(x,y)$ is infinite at certain points, if the high-frequency Fourier component of the intensity distribution is neglected, $I_W(x,y)$ is nearly equal to $I_g(x,y)$. A.

535.31 : 535.42

1584. LIGHT TRANSMITTED BY VERY SMALL PINHOLES. P.N.Slater and W.Weinstein.
J. Opt. Soc. Amer., Vol. 48, No. 3, 146-9 (March, 1958).

When an optical system is illuminated by a pinhole of unresolvable size, light flux is lost by diffraction at the pinhole if the usual conditions for full-cone illumination are satisfied. Formulae are given for this loss and it is shown that for a pinhole small enough to appear as a true point source an illuminating cone of three or more times the angle of the cone accepted by the optical system must be used to avoid substantial light loss. Experimental confirmation is given. A.

535.314 : 551.46

ON THE FOCUSING OF SUNLIGHT BY OCEAN WAVES. See Abstr. 1373

535.317 : 535.81

1585. GENERALIZED THEORY OF ZOOMAR SYSTEMS. F.G.Back and H.Lowen.
J. Opt. Soc. Amer., Vol. 48, No. 3, 149-53 (March, 1958).

The basic theory of a Zoomar system was illustrated in a previous paper for a three lens system. The present paper generalizes this theory to cover any Zoomar system and illustrates the development of the Zoomar system by selected examples of applications. A.

535.317

1586. THE ADJUSTMENT OF OPTICAL SYSTEMS. W.S.Blaschke.
J. sci. Instrum., Vol. 34, No. 10, 392-3 (Oct., 1957).

The most efficient method of adjusting an optical system to satisfy prescribed Gaussian conditions is given. Additional formulae relate such adjustments to errors present in the components of the system. A.

535.317

1587. THE NUMERICAL EVALUATION OF THE FREQUENCY RESPONSE OF OPTICAL SYSTEMS. H.H.Hopkins.
Proc. Phys. Soc. B, Vol. 70, Pt 10, 1002-5 (Oct., 1957).

A method of evaluating $\iint \exp if(x,y)dxdy$ over an irregular domain. f(x,y) is replaced by the constant and linear terms of its Taylor expansion about the centres of rectangular sub-domains and the integral is replaced by a summation over them. Examples of frequency response so calculated are given. W.Weinstein

535.317.1

1588. GENERAL THEORY OF OPTICALLY COMPENSATED VARIFOCAL SYSTEMS. L.Bergstein.
J. Opt. Soc. Amer., Vol. 48, No. 3, 154-71 (March, 1958).

It is shown that n alternately stationary and relatively fixed (to each other) movable lens components can be arranged to produce an optical system which will have an over-all focal length variable continuously between any two predetermined values upon a displacement of the movable components from their reference position. While the movable interconnected system is being displaced from one extreme position to the other to change the overall focal length the final image of the system will pass n times through the same position in space; the deviation of the image plane from a predetermined reference plane will be zero in n predetermined positions of the movable components and will not exceed a predetermined value at intermediate positions. The minimum number n of required components is determined by the desired operating range of focal lengths and the tolerable limit of the image plane deviation. The 2n-2 Gaussian parameters of the n-lens system are then found from a system of 2n-2 equations and inequalities. A.

535.317.3

1589. SECONDARY CHROMATIC ABERRATION. R.E.Stephens.
J. Opt. Soc. Amer., Vol. 47, No. 12, 1135 (Dec., 1957).

The length of the secondary spectrum was calculated for an F/8 Petzval type objective of 40 in. focal length and $3\frac{1}{2}^0$ semi-field. It was found to be about half that of lenses of the following types with equal Gaussian properties: thin achromat, dialyte objective, telephoto objective and Taylor triplet. Thus for Rayleigh limit aberration correction the Petzval objective can be made with larger focal length or aperture than lenses of the other types mentioned. W.Weinstein

535.322.4

1590. FIBER OPTICS. IV. A PHOTOREFRACTOMETER. N.S.Kapany and J.N.Pike.
J. Opt. Soc. Amer., Vol. 47, No. 12, 1109-17 (Dec., 1957).

For Pt III see Abstr. 7708 (1957). A photorefractometer to determine slight changes in refractive index of a liquid is described. When a long dielectric cylinder is immersed in a specimen liquid and an axial light cone is condensed at one end, the energy transmitted by total internal reflections through the cylinder depends primarily on δ, the difference in refractive index of the rod and the surround. Thus change in index of the surround liquid is related to change in emergent flux from the immersed rod. If the photometric unit is capable of detecting 100 K% change in emergent energy, and if $\delta \lesssim 0.1$, then changes in liquid index of $K \cdot \delta$ can be detected. By proper choice of K and δ, a change in index of 10^{-6} is measurable. An instrument based on this principle was constructed and the experimental results show good agreement with theory. The effects of absorption, reflection losses at the two ends of the rod, and partial reflection within the rod on the sensitivity of the system are studied theoretically. It also seems possible to measure the low refractive index liquids by the use of a hollow rod refractometer. Various applications of this photorefractometer principle are indicated. A.

535.322.4

1591. SELF-BALANCING LABORATORY DIFFERENTIAL REFRACTOMETER. C.J.Penther and G.W.Noller.
Rev. sci. Instrum., Vol. 29, No. 1, 43-6 (Jan.,1958).

This refractometer is used in conjunction with a light scattering apparatus to determine high molecular weights. The self-balancing feature relieves the operator of the tedium of making delicate visual observations while retaining high sensitivity and accuracy. Mounted on a shop surface-plate it measures 15 in. wide by 18 in. long by 7 in. high exclusive of the light source transformer. A Brown Electronik amplifier and servomotor are used to position the photocells on the light beam with a repeatability of about 30 microinches. The beam deflection is read on a counter and vernier dial. The range of the instrument is 0.0175 R.I. units and the stability and accuracy are within 5×10^{-7} R.I. units. Differential refractometers are also useful in following fractionation by distillation or adsorption, in determining concentrations of colourless solutes in dilute solutions and in studying sedimentation equilibrium. A.

535.323 : 535.345

1592. MEASUREMENT OF OPTICAL CONSTANTS OF TIN BY AN INTERFEROMETRIC METHOD. I.N.Shklyarevskii and N.A.Nosulenko.
Optika i Spektrosk., Vol. 2, No. 5, 658-61 (1957). In Russian.

Optical constants of tin were measured in the visible region of spectrum. From the values of refractive index and coefficient of absorption an approximate concentration of conduction electrons in tin was found. S.Chomet

535.33.03 : 539.18

1593. A NEW METHOD OF SPECTRUM EXCITATION IN AN ATOMIC BEAM. V.A.Gromov.
Optika i Spektrosk., Vol. 2, No. 5, 669-71 (1957). In Russian.

At present, three methods of excitation of the emission spectrum of an atomic beam are known: (1) by an electron beam; (2) by a high-frequency electromagnetic field in an inert gas, and (3) by resonance excitation using light. All these methods possess certain disadvantages. The author reports a new method of excitation in an atomic beam, using simultaneously the action of an electron beam and a high-frequency electric field. The efficiency of excitation in an atomic beam which crosses the electron beam with the high-frequency field superimposed on it should be higher than the efficiency of excitation using electrons without the high-frequency field. The reasons for that are as follows: (a) increase of the time spent by an electron in the atomic beam; (b) traversing the atomic beam, an electron is accelerated and decelerated many times, which should increase the probability of excitation; (c) further electrons are produced by ionization of the atomic beam. If the high-frequency field is sufficiently powerful and the atomic beam sufficiently intense, a spontaneous, electrodeless, high-frequency discharge will be produced. An atomic beam of magnesium was excited using electrons with and without a high-frequency field. It was found that the intensity of the wavelengths 4481, 5173, 5184, 5528 A excited in the magnesium beam was 2-4 times higher, using the high-frequency field than without it. S.Chomet

535.33.08

1594. ARTIFACT IN SPECTROPHOTOMETRY CAUSED BY FLUORESCENCE.
A.H.Mehler, B.Bloom, M.E.Ahrendt and DeW.Stetten, Jr.
Science, Vol. 126, 1285-6 (Dec. 20, 1957).

False readings are obtained with single-monochromator ultraviolet absorption spectrophotometers, when there is background fluorescence from the specimen or the silica cuvettes. The magnitudes of these effects are illustrated, and methods of reducing or eliminating them with double-monochromator systems are discussed. J.B.Birks

535.331

1595. ISOTOPE SHIFT IN THE RESONANCE LINES OF Mg I. F.M.Kelly.
Canad. J. Phys., Vol. 35, No. 10, 1220-2 (Oct., 1957).

Measurements of the isotope shift in λ2852 ($3\,{}^1S_0 - 3\,{}^1P_1$) and λ4571 ($3\,{}^1S_0 - 3\,{}^3P_1$) of Mg I are reported. The measurements are compared with other results and with theoretical calculations. A.

535.331

1596. LOWEST TERM OF THE $3d^{n-2}4s^2$ CONFIGURATION, IN THE Ni III SPECTRUM. O.García-Riquelme.
J. Opt. Soc. Amer., Vol. 48, No. 3, 183-4 (March, 1958).

In the Ni III spectrum, at 153 000 K part of a ^5D term due to the $3d^84s^2$ configuration, was found. For the first time, in a third spectrum of an element of the first group of transition elements, the configuration $3d^{n-2}4s^2$ is located. Eleven lines are classified with the new term. A.

535.331

1597. STRUCTURE OF THE BARIUM RESONANCE LINE. J.E.Mack.
Phys. Rev., Vol. 109, No. 3, 820-2 (Feb. 1, 1958).

For the Ba I line $6s^2\,{}^1S_0 - 6s6p\,{}^1P_1$, the structure

$$0.0^{138}[-3.1_{5/2}, +9.9_{3/2}, +17.7_{1/2}]^{137} + 3^{136}[-0.3_{5/2}, +11.4_{3/2}, +18.4_{1/2}]^{135} + 5^{134}$$

is suggested as being consistent with the experimental evidence (subscripts are $^1P_1$ F-values; superscripts, isotopes; numbers on the line, wave-numbers relative to isotope 138, expressed in $mK \equiv 10^{-3}\ cm^{-1}$). A.

535.331

1598. NOTE ON THE Li II SPECTRUM. G.W.Series and K.Willis.
Proc. Phys. Soc., Vol. 71, Pt 2, 274 (Feb., 1958).

The λ 8517.1 ± 1.5 A ($1s2p\,{}^1P_1 - 1s2s\,{}^1S_0$) Li II line, whose

position was predicted by extrapolation of the 1s2s $^1S_0$ level, has now been excited in a hollow-cathode discharge through Li.

R.W.Nicholls

535.333

1599. RADIATION FROM HOT AIR. I. THEORY OF NITRIC OXIDE ABSORPTION. B.Kivel, H.Mayer and H.Bethe.
Ann. Phys. (New York), Vol. 2, No. 1, 57-80 (July, 1957).

A procedure is devised for estimating the contribution of the NO β and γ bands to the emissivity of high-temperature air. The results agree well with more detailed calculations. The emissivity is found to be insensitive to the detailed line structure because there are many lines which smear into a continuum. The main unknown is the absolute intensity, so that the data must be presented with the f number (oscillator strength) as a parameter. For aid in spectroscopic identification a partial profile of the emission from an optically thin gas at 8000° K is sketched. A.

535.333 : 536.461

EMISSION SPECTRA OF PROPANE–AIR FLAMES IRRADIATED WITH A 1000 CURIE GOLD SOURCE. See Abstr. 1021

535.333 : 534.222.2

1600. EXCITATION OF MOLECULAR SPECTRA BY SHOCK WAVES. J.G.Clouston and A.G.Gaydon.
Nature (London), Vol. 180, 1342-4 (Dec. 14, 1957).

Direct photographs and time-resolved photomultiplier records of spectra of air, N_2, O_2, CO, CO_2 and H_2 mixtures with argon are described. Impurity lines (Na, Ca, etc.) lag about 30 μsec behind the continuous emission and are attributed to scrubbing of dust from the walls. C_2 emission occurs in the shock front. N_2 with argon gives First Negative bands and some Second Positive, but not First Positive. O_2 gives Schumann–Runge bands. Air gives Schumann–Runge bands in low-temperature shocks, N_2 and NO γ-bands in hotter shocks. CO and CO_2 give C_2 bands, and CH as well if H_2 is present. H_2 gives Balmer lines, broadening of which indicates temperatures up to 12 000° K. Excitation processes are discussed.

A.G.Gaydon

535.333 : 539.18

1601. ELECTRONIC EMISSION SPECTRA OF THE CARBON DISULPHIDE ION, CS_2^+. J.H.Callomon.
Proc. Roy. Soc. A, Vol. 244, No. 1237, 220-44 (1958).

Two band systems, A and B, have been observed in emission from the negative glow (in a hollow cathode) of a d.c. discharge through streaming carbon disulphide vapour. Both show rotational structure when photographed on a 20 ft grating spectrograph; that of the strongest bands of system A near 2800 A has been completely analysed, and is ascribed to a transition $^2\Sigma_u^+ \rightarrow X\ ^2\Pi_g(i)$ case (a) of linear CS_2^+. The bond distances $r_0(CS)$ were found to be 1.5641 and 1.5542 (±0.0004) A, respectively. System B extends from the near ultraviolet into the infrared region, with few regular features. The irregular and closely packed rotational structure suggests non-linear configurations for the states involved. A.

535.333

1602. AN EXPERIMENTAL STUDY OF THE BAND INTENSITIES IN THE CN RED SYSTEM. R.N.Dixon and R.W.Nicholls.
Canad. J. Phys., Vol. 36, No. 1, 127-33 (Jan., 1958).

Experimental band intensities in the CN red system, $A(^2\Pi_i) \rightarrow X(^2\Sigma^+)$, were measured using an active nitrogen–carbon tetrachloride source. Using calculated Franck–Condon factors $q_{v'v''}$ the electronic transition moment $R_e(r)$ is found to vary little over the range $1.04 < r < 1.27$ A. A.

535.333 : 539.19

1603. THE BAND SPECTRUM OF SILICON MONOFLUORIDE, SiF. J.W.C. Johns and R.F.Barrow.
Proc. Phys. Soc., Vol. 71, Pt 3, 476-84 (March, 1958).

The emission spectrum of SiF has been examined in the Schumann and infrared regions. The system B–A ($\nu_{0,0}$ = = 11850.8 cm^{-1}) is strong, and rotational analysis shows that both states are $^2\Sigma$. A new rotational analysis of the 0,0 band of the α-system, $A–X^2\Pi$, although in substantial agreement with earlier work, confirms the view that state A is $^2\Sigma^+$, and not $^2\Pi$ (case-b), as had previously been supposed. Violet degraded bands which have tentatively been ascribed to five systems, all with $X^2\Pi$ as the ground state, are found, partly superimposed, in the region 51 000 to 53 500 cm^{-1}. Three of the excited states of SiF appear to form a Rydberg series of $^2\Sigma^+$ states leading to the ground state $\ldots\pi^4\sigma^2$, $^1\Sigma^+$ of SiF^+. The ionization potential is found to be 7.2$_6$ eV. Evidence about the dissociation energy is briefly considered; the best value seems to be $D_0''(SiF) \sim 125$ kcal. A.

535.34.07

1604. DIELECTRIC ROD WAVE-GUIDE CELLS FOR MICROWAVE SPECTROSCOPY. E.B.Brackett, P.H.Kasai and R.J.Myers.
Rev. sci. Instrum., Vol. 28, No. 9, 699-702 (Sept., 1957).

The distribution of microwave power around a quartz rod excited in the dipole mode is calculated. On the basis of these data, quartz rod sizes were selected for cells covering the region from 17 000 to 60 000 Mc/s. All quartz and Teflon window cells were constructed, and the Teflon window type was found to have good transmission and high sensitivity. A.

535.343

1605. ABSORPTION SPECTRA OF THE HALOGEN MONOXIDES. R.A.Durie and D.A.Ramsay.
Canad. J. Phys., Vol. 36, No. 1, 35-53 (Jan., 1958).

Absorption spectra of ClO, BrO, and IO were observed during the flash photolysis of $Cl_2–O_2$, $Br_2–O_2$, and $I_2–O_2$ mixtures. Rotational and vibrational analyses of the ClO and BrO spectra have been carried out and appropriate molecular constants derived. The transitions are of the type $^2\Pi_i$(case a)–$^2\Pi_i$(case a). Extensive predissociation was observed in all three spectra. Theoretical and experimental evidence is presented to show that the excited states dissociate to $X(^2P_{3/2}) + O(^1D)$. From the observed or extrapolated convergence limits of the absorption spectra the dissociation energies of the ground states are shown to be $D_0''(ClO) = 63.31 \pm 0.03$ kcal/mole, $D_0''(BrO) = 55.2 \pm 0.6$ kcal/mole, $D_0''(IO) = 42 \pm 5$ kcal/mole. Mechanisms for the production of the halogen monoxides are discussed and evidence is presented for the participation of excited $^2P_{1/2}$ halogen atoms. A.

535.343

1606. FAR ULTRAVIOLET ABSORPTION SPECTRA OF SMALL RING HYDROCARBONS. B.B.Loeffler, E.Eberlin and L.W.Pickett.
J. chem. Phys., Vol. 28, No. 2, 345-7 (Feb., 1958).

Molar extinction coefficients for the far ultraviolet absorption of cyclobutene, 1-methylcyclobutene and methylenecyclobutane were measured between 40 000 cm^{-1} and 64 000 cm^{-1}. These spectra show the characteristic absorption of π-electrons with oscillator strengths of 0.3 and with band positions which are explicable on the basis of molecular structure. Photodecomposition to give ethylene was observed in the case of methylenecyclobutane and 1-methylcyclobutene. A.

535.343

1607. ULTRAVIOLET SPECTRA OF LiH AND LiD. R.Velasco.
Canad. J. Phys., Vol. 35, No. 10, 1204-14 (Oct., 1957).

The absorption spectra of LiH and LiD were observed in the near ultraviolet with high dispersion and absorbing path lengths up to 16 m. A new band system was found in each molecule involving the ground state and a $^1\Pi$ excited state. Rotational and vibrational analyses of this system were carried out and rotational and vibrational constants for the upper state determined. The observed breaking off of the rotational structure of the bands of this $B\ ^1\Pi–X\ ^1\Sigma^+$ system is interpreted as due to predissociation by rotation. With this assumption very accurate dissociation limits of the B $^1\Pi$ state were obtained. From these dissociation limits the dissociation energies of the three known electronic states of LiH and LiD are calculated. In particular the dissociation energies (D_0) of the ground states of LiH and LiD were found to be 2.4288 ± 0.0002 eV and 2.4509 ± 0.0010 eV, respectively. A.

535.343

1608. INFRARED SPECTRA OF THE ISOTOPIC NITROUS OXIDES. G.M.Begun and W.H.Fletcher.
J. chem. Phys., Vol. 28, No. 3, 414-18 (March, 1958).

The infrared spectra of $N^{14}N^{15}O^{16}$, $N^{15}N^{14}O^{16}$, and $N^{15}N^{15}O^{16}$ were observed from 2.5μ to 20μ. The frequencies of the three fundamental vibrational bands and fifteen overtone and combination bands are tabulated and compared with the frequencies of $N^{14}N^{14}O^{16}$. Using known anharmonic constants and isotopic relations, approximate zero-order frequencies are calculated for the isotopic molecules. A set of force constants for infinitesimal displacements are computed for the set of molecules, and the partition function ratios for the various species calculated from the data. A.

535.343

1609. INFRARED SPECTRA OF HCl–HBr MIXED CRYSTALS. G.L.Hiebert and D.F.Hornig.
J. chem. Phys., Vol. 28, No. 2, 316-18 (Feb., 1958).

The spectra consist of a band characteristic of chains of similar molecules plus a line caused by the end molecule in any chain,

this structure being repeated in the HCl and HBr regions. The frequency of HBr when hydrogen bonded to HCl is higher than when bonded to another HBr; that of HCl is lower when bonded to HBr than when bonded to another HCl. A.

535.343 : 539.2

1610. THE INFRA-RED SPECTRUM OF DIAMOND. M.J.Stephen.
Proc. Phys. Soc., Vol. 71, Pt 3, 485-90 (March, 1958).

The contribution of lattice vibrations to the infrared spectrum of diamond in the 2 to 6 μ region has been calculated from the vibrational frequency distribution where second nearest neighbour central forces are taken into account. It is assumed that this absorption is associated with two-phonon processes arising from second-order terms in the electric moment. Certain general selection rules are determined. Most of the details of the observed spectrum are reproduced in the calculated spectrum. A.

535.343

1611. INFRARED SPECTRUM OF METHYL CHLORIDE NEAR 6000 cm^{-1}. R.G.Brown and T.H.Edwards.
J. chem. Phys., Vol. 28, No. 3, 384-8 (March, 1958).

The rotational fine structure of the parallel component of $2_{\nu 4}$ of methyl chloride was resolved. The Q branches of the sub-bands, and the P and R branch lines of the K = 3 sub-band were identified and analysed. The molecular constants obtained are (in cm^{-1}): $\nu_0 = 6015.56$, $B' = 0.4439$, $B'' = 0.4436$, $B'-B'' = 0.00044$, and $(A'-B') - (A''-B'') = -0.0481$. A.

535.343 : 539.19

INFRARED SPECTRA OF MONOMERIC FORMIC ACID. See Abstr. 793

535.343

1612. NONRESONANT ABSORPTION OF SYMMETRIC TOP MOLECULES. SHAPE OF THE NONRESONANT SPECTRA. G.Birnbaum.
J. chem. Phys., Vol. 27, No. 2, 360-8 (Aug., 1957).

The nonresonant or relaxation absorption spectrum was mapped out for the symmetric top molecules CH_3F, CH_3Cl, CH_3Br, CH_3I, CH_3CN, CHF_3, $CClF_3$ and $(CH_3)_3N$. A cavity method was used to determine the absorption at several frequencies in the range 1200 to 24 000 Mc/s at pressures up to 12 atm unless limited by the vapour pressure. Absorption due to the rotational lines was found to be important unless the frequency and pressure were kept sufficiently low. The results for $CClF_3$ and $(CH_3)_3N$ closely fit the Debye equation and lead to an accurate evaluation of the dipole moment, namely, $0.50_0 \times 10^{-18}$ e.s.u. and $0.60_1 \times 10^{-18}$ e.s.u., respectively. The nonresonant spectra of the remaining molecules, which have larger dipole moments, deviate from the Debye shape in a manner that is characteristic of a distribution of line widths. A.

535.345

1613. A THEORY OF IMPURITY ABSORPTION OF LIGHT IN MOLECULAR CRYSTALS. É.I.Rashba.
Optika i Spektrosk., Vol. 2, No. 5, 568-77 (1957). In Russian.

Mathematical paper. When complex organic molecules are introduced as impurities into organic molecular crystals, the impurity and intrinsic absorption spectra usually overlap. Frequently, even the long-wavelength lines of the impurity spectrum are near the edge of the intrinsic absorption. Under these conditions, a strong, and very intensely dichroic, intrinsic absorption may alter the intensity and polarization of the impurity absorption. This effect is studied in the present paper for the case of crystals with undisplaceable molecules, when it is not masked by the interaction of electron-excitation with lattice vibrations. A molecular crystal is discussed in which one or several molecules are replaced by impurity molecules. It is assumed that one energy level of the impurity molecules and one energy level of the solvent molecules lie comparatively close to one another, and are separated by a wide gap from all the other levels. The Heitler–London method was used and antisymmetrized products of all possible intermolecular wave-functions were chosen as the basis of calculations. S.Chomet

535.345

1614. ON THE THEORY OF ABSORPTION OF ELECTROMAGNETIC WAVES IN METALS IN THE INFRARED REGION OF THE SPECTRUM. R.N.Gurzhi.
Zh. éksper. teor. Fiz., Vol. 33, No. 3(9), 660-8 (1957). In Russian.

Absorption of electromagnetic waves by metals in the infrared region is considered by employing the method of a quantum kinetic equation. The quantum properties of the electromagnetic field and anomalous character of the skin effect are taken into account. A.

535.345 : 539.213.2 : 537.311.33

OPTICAL ABSORPTION OF VITREOUS SEMICONDUCTORS. See Abstr. 1048

535.371

1615. FLUORESCENCE INTENSITY RATIO OF SODIUM DOUBLET OBSERVED IN THE OPTICAL DISSOCIATION OF SODIUM IODIDE VAPOR. H.G.Hanson.
J. chem. Phys., Vol. 27, No. 2, 491-4 (Aug., 1957).

The intensity ratio D_2/D_1 for the sodium doublet was measured for radiation from excited sodium atoms which result from the optical dissociation of sodium iodide vapour by ultraviolet light in the 2082–2500 A region. With shorter wavelength ultraviolet light as exciting source, the D_2/D_1 ratio is 0.98 and increases to above 1.5 with longer exciting wavelengths. Addition of foreign gases cause the observed D_2/D_1 ratio to increase to 1.89 for large foreign gas pressure. Cross-sections for the transfer of excited sodium atoms from the $3^2P_{3/2}$ to the $3^2P_{1/2}$ state and vice versa due to collisions with foreign molecules were measured as they depend on the relative velocity between excited sodium atom and foreign molecule. The Doppler broadening of the separate D lines emitted in the atomic fluorescence of sodium iodide was estimated from absorption measurements. Both lines show equal broadening within the experimental error of the observations. Measurements were made with a photomultiplier tube. The sodium doublet was resolved with a reflection grating monochromator. A.

535.371

1616. CONCENTRATION DEPENDENCE OF QUANTUM EFFICIENCY OF LUMINESCENCE IN KCl:Tl.
J.H.Schulman, E.W.Claffy and R.J.Potter.
Phys. Rev., Vol. 108, No. 6, 1398-401 (Dec. 15, 1957).

Quantum efficiency measurements for the 3050 A emission band of KCl:Tl under 2470 A excitation are reported and compared with earlier data. In the present work, the average quantum efficiency is found to be 80 ± 5% over a concentration range of 4×10^{-3} to 8×10^{-1} mole % Tl. Concentration quenching, if it exists in this range, is only slightly greater than the experimental error. This result is consistent with the Dexter–Schulman proposal of the importance of transfer processes in concentration quenching. A.

535.371

1617. INSTRUMENT TO MEASURE FLUORESCENCE LIFETIMES IN THE MILLIMICROSECOND REGION. S.S.Brody.
Rev. sci. Instrum., Vol. 28, No. 12, 1021-6 (Dec., 1957).

The instrument utilizes a hydrogen flash-lamp and high-speed oscilloscope. The fluorescence decay is displayed on the oscilloscope, and using the method of moments the observed fluorescence is corrected for the response of the lamp and the detection equipment. The instrument was used to study the primary photochemical processes of photosynthesis. Measured lifetimes are given for the various photosynthetic pigments (in vitro), some organic dyes, and chlorophyll fluorescence in algae. With this instrument it is possible to measure the delayed energy transfer in living systems. A.

535.372

1618. ANALYSIS OF EXCITATION SPECTRA MEASUREMENT. A.Lempicki.
J. Opt. Soc. Amer., Vol. 48, No. 1, 67-70 (Jan., 1958).

The experimental difficulties due to reflection from the specimen in measuring excitation spectra of phosphors are discussed. Three new methods allowing the separation of emitted and reflected radiation are proposed. Two are based on periodic excitation and the analysis of resulting signal waveforms. The third is based on a separate measurement of the reflection. A.

535.376

1619. THE LUMINESCENCE RESPONSE OF PHOSPHORS TO LOW ENERGY ION BOMBARDMENT. C.F.Eve and H.E.Duckworth.
Canad. J. Phys., Vol. 36, No. 1, 104-16 (Jan., 1958).

The luminescence response of samples of ZnS:Ag and Zn_2SiO_4:Mn to bombardment with various ions was determined as a function of the ion energy. For ZnS:Ag, within the range of ion energies studied ($E < 25$ keV), the luminescence response, L, is related to the ion energy, E, according to $L \propto (E - E_0)^n$. E_0 is a threshold energy which is not a very sensitive function of ion mass. For Zn_2SiO_4:Mn no threshold energy was observed except in the case of Li^{2+} ions, the lightest ions used with this phosphor. The experimental results for ZnS:Ag appear to be consistent with a theory in which it is assumed that the bombarding particles penetrate the phosphor as neutral atoms and produce luminescence by electronic excitation of the lattice atoms due to small impact parameter collisions. A.

535.376

1620. DECAY TIMES OF FLUORESCENT SUBSTANCES EXCITED BY HIGH-ENERGY RADIATION.
H.Kallmann and G.J.Brucker.
Phys. Rev., Vol. 108, No. 5, 1122-30 (Dec. 1, 1957).

Decay times of fluorescent light emitted by organic solutions and by organic and inorganic solids when excited by high-energy radiation were determined under various experimental conditions. The pulse-height ratios for alpha-particle and electron excitation were also found. The probabilities for radiative and nonradiative transitions of the light emitting molecule are estimated and compared with values obtained from absorption measurements. The time required for energy transfer is estimated. The ratio of pulse heights obtained under alpha-particle excitation to those obtained under electron excitation are found to be roughly the same for all organic solutions and solids despite wide variations in lifetime; also no difference in lifetime between alpha-particle and electron excitations is found. This is not explained by present theories. A new theory to explain these facts is outlined. A.

535.376 : 628.9.03

1621. SOLID-STATE LIGHT AMPLIFIERS.
B.Kazan and F.H.Nicoll.
J. Opt. Soc. Amer., Vol. 47, No. 10, 887-94 (Oct., 1957).

A description is given of the different types of solid-state image intensifiers together with a comparison of their methods of operation. The characteristics of photoconductive and electroluminescent materials are summarized with particular emphasis on the problems of their optimum combination in the double-layer type of intensifier with and without optical feedback. The optical and electrical characteristics of the overall devices are compared, and some of the possible applications, such as their use for radar display and X-ray intensification, are discussed. A.

535.376

1622. GRAIN BOUNDARIES AND ELECTROLUMINESCENCE IN GALLIUM PHOSPHIDE. D.A.Holt, G.F.Alfrey and C.S.Wiggins.
Nature (London), Vol. 181, 109 (Jan. 11, 1958).

Electroluminescence is observed mostly at grain boundaries in the surface. This is attributed to p—n—p junctions, in which the n-layers result from impurity segregation. S.T.Henderson

535.376

1623. ELECTROLUMINESCENT COPPER-ACTIVATED ZINC SULPHIDE. A.A.Cherepnev.
Optika i Spektrosk., Vol. 2, No. 6, 770-4 (1957). In Russian.

Describes the electroluminescent ZnS:Cu phosphors emitting blue and green luminescence and prepared at different temperatures with a varying activator content, using NaCl and H_3BO_3 as fluxes. Discusses the flash emission and quenching phenomena. The electroluminescence phenomena are obviously related to the presence of conducting particles (Cu_2S, perhaps also ZnO and metals).

F.Lachman

535.376

1624. THERMOLUMINESCENCE OF X-RAY-COLORED KCl SINGLE CRYSTALS. A.Halperin, A.A.Braner and E.Alexander.
Phys. Rev., Vol. 108, No. 4, 928-31 (Nov. 15, 1957).

Thermoluminescence curves of KCl single crystals were recorded. Twelve glow peaks were obtained in the temperature range of 90-600°K. The glow peaks seem to show regularity with regard to their peak temperatures, spectral emission and sensitivity to optical bleaching in the F-band. Effects of ageing of the crystals are reported. Activation energies for several peaks as calculated from the results are also given. A.

535.393 : 539.234

1625. INFRARED REFLECTANCE OF EVAPORATED METAL FILMS. D.M.Gates, C.C.Shaw and D.Beaumont.
J. Opt. Soc. Amer., Vol. 48, No. 2, 88-9 (Feb., 1958).

A high-precision method of measuring the reflectance of evaporated metal films is described and the results for aluminium and silver as a function of wavelength (visible to 13 microns) and angle of incidence (20° to 60°) are reported. The apparatus was constructed as an accessory to an infrared spectrometer using a NaCl prism. A well-collimated beam of infrared radiation was reflected from two parallel glass plates of dimensions 3 in. by 10 in. which were coated with the surface to be measured. The intensity of the radiation after being reflected from the parallel mirrors 2, 4, 6, 8 and 10 times was recorded by the pen and ink recorder of the spectrograph and the reflectance was determined as a root of the ratios of these readings. The reflectances measured are accurate to 0.2%. A.

535.393

1626. THIN-LAYER OPTICS. I. PHASE-SHIFT ON REFLECTION OF LIGHT FROM THIN FILMS OF SILVER, GERMANIUM, TELLURIUM AND SELENIUM. M.P.Lisitsa and N.G.Tsvelykh.
Optika i Spektrosk., Vol. 2, No. 5, 674-6 (1957). In Russian.

By thin films the authors understand transparent or nontransparent layers whose properties depend on their thickness and differ from the properties of bulk samples. This paper studies quantitatively the phase-shifts, δ, of the reflected light for films of silver, germanium, tellurium and selenium when the thickness (up to 1200 A) of these films changes. For each metal there is a phase-shift minimum at the lowest thicknesses. In addition to that minimum, there is at least one maximum of phase-shift for each substance. Silver differs from the other three semiconducting substances by reaching a value $\delta = 1.2\pi$ at a thickness of ~100 A, and this value does not materially vary with further increase in thickness. Semiconductors, on the other hand, show further minima and maxima in the phase-shift with increase in thickness. These differences may be related to the structure of the films (it is known that silver and tellurium films are crystalline, selenium and germanium are amorphous).

S.Chomet

535.41

1627. ILLUSTRATION OF THE PHASE CHANGE IN TWO-BEAM INTERFERENCE WITH PARTIALLY COHERENT LIGHT.
B.J.Thompson.
J. Opt. Soc. Amer., Vol. 48, No. 2, 95-7 (Feb., 1958).

The change in phase that occurs in the degree of coherence is investigated by a method involving two-beam interference with partially coherent light. Examples are given to illustrate the phase change, and a comparison made with the theoretical predictions. A.

535.414 : 535.322.4

1628. PRINCIPLE OF AN INTERFERENCE REFRACTOMETER.
N.Barakat and H.Nooh.
J. Opt. Soc. Amer., Vol. 48, No. 2, 90-2 (Feb., 1958).

Interference taking place when a parallel beam of monochromatic light is incident normally on a wedge interferometer, with highly reflecting surfaces enclosing a refracting medium is studied theoretically. The theory predicts the presence of a number of planes of localization other than the Feussner plane of fringe localization of zero order close to the wedge. Brossel's formula giving Feussner surfaces of high orders is a special case when the refractive index of the enclosed medium equals unity. The derived formula is verified experimentally. The refractive index of the enclosed medium is determined by measuring the fringe separation and the distance between any two successive planes of localization. A.

535.417 : 535.345.6

1629. DESIGN OF MULTILAYER FILTERS BY CONSIDERING TWO EFFECTIVE INTERFACES. S.D.Smith.
J. Opt. Soc. Amer., Vol. 48, No. 1, 43-50 (Jan., 1958).

Any nonabsorbing multilayer system may be completely described by two effective interfaces. An analysis based on this representation is applied to deduce the properties of systems consisting of one or two half-wave layers surrounded by reflecting stacks. The salient features of the transmission characteristics are easily obtained. The conditions to be fulfilled in the design of bandpass filters of various bandwidths and of low-(frequency) pass filters are deduced. It is shown that double half-wave systems have theoretical advantages in band shape and peak transmission over single half-wave systems. This is confirmed experimentally. A.

535.417

1630. SYNCHRONOUS WAVELENGTH SWEEP OF A DIFFRACTION GRATING AND FABRY—PEROT INTERFEROMETER.
J.G.Hirschberg and R.R.Kadesch.
J. Opt. Soc. Amer., Vol. 48, No. 3, 177 (March, 1958).

To obtain a wavelength sweep of a Fabry—Perot interferometer and a diffraction grating, both may be placed in communicating pressure chambers in which the gas pressure is varied with time. If the pressure in the two chambers is always equalized, the sweep will be synchronous. A.

535.42

1631. INFLUENCE OF LIGHT SOURCE SIZE ON DIFFRACTION BY AN OPAQUE STRIP. B.Marković.
J. Opt. Soc. Amer., Vol. 47, No. 12, 1074-5 (Dec., 1957).

The effect of the extension of the light source on the interference fringes in the geometrical shadow of an opaque strip is examined. A relation between the width of the light source, the distance of the light source to the opaque strip, and the wavelength on which the interference fringes may be seen is established. A.

535.434

1632. CORRELATION THEORY OF RAYLEIGH SCATTERING OF LIGHT. I. S.M.Rytov.
Zh. éksper. teor. Fiz., Vol. 33, No. 2(8), 514-24 (1957). In Russian.

A phenomenological theory of Rayleigh scattering of light is proposed for an isotropic viscoelastic medium on the basis of the thermal-fluctuation correlation theory previously developed for such media. General (i.e. arbitrary dispersion of parameters of the media is permissible) expressions for the spectral intensities of the scattered light have been obtained which correspond to various polarization conditions. As an application of the general formulae an expression has been obtained (under some assumptions regarding the form of the dispersion formulae) which yields the integral intensity of light scattered on isotropic fluctuations. The case of a weakly viscous fluid is considered as well as the dispersion correction to the Einstein formula for this case. A.

535.434

1633. CORRELATION THEORY OF RAYLEIGH SCATTERING OF LIGHT. II. S.M.Rytov.
Zh. éksper. teor. Fiz., Vol. 33, No. 3(9), 669-82 (1957). In Russian.

Some further consequences of the general formulae deduced in Pt I (see preceding abstract) for the spectral intensities of scattered light are considered. The integral intensities of the fine-structure components of the isotropic part of Rayleigh scattering have been obtained for a medium with small viscous and thermal losses by choosing the dispersion laws in a special form. The dispersion corrections and Landau—Plachek relation are considered in greater detail for the case of a liquid of low viscosity. Results of the general theory which refer to anisotropic scattering are considered and some simple dispersion laws are indicated which yield a satisfactory approximation of the observed intensity distribution in the wing of the Rayleigh line for a liquid of low viscosity. These laws are used to compute the integral intensities and an approximate formula has been obtained for the depolarization coefficient of Rayleigh scattering. A.

535.435

1634. CONCERNING SCATTERING OF LIGHT IN He^3 AND He^4 MIXTURES. L.P.Gor'kov and L.P.Pitaevskii.
Zh. éksper. teor. Fiz., Vol. 33, No. 3(9), 634-6 (1957). In Russian.

Scattering of light in He^3 and He^4 mixtures below the λ-point is considered. It is shown that five lines are involved in the spectral distribution of the scattered light. Formulae for the intensities of the lines are presented and the problem of their width is briefly considered. A.

535.515 : 535.345.6

1635. SOLC BIREFRINGENT FILTER. J.W.Evans.
J. Opt. Soc. Amer., Vol. 48, No. 3, 142-5 (March, 1958).

A new birefringent filter composed of a series of retardation plates between a single pair of polarizers has been described by Solc. The filter is analyzed and compared with the Lyot filter. It is found that the Solc filter is inferior to the Lyot filter in the suppression of parasitic light in secondary maxima near the primary transmission bands, although its band width is slightly less, and its transparency is very much better if both filters use Polaroid film for polarizers. A.

535.551

1636. STRESS-OPTICAL STUDY OF STRONTIUM TITANATE. A.A.Giardini.
J. Opt. Soc. Amer., Vol. 47, No. 8, 726-35 (Aug., 1957).

This work represents the first stress-optical study of strontium titanate ($SrTiO_3$). The report includes a brief review of previous stress-optical work on crystals, a brief review of synthetic $SrTiO_3$, and a brief review of stress-optical theory. The remainder of the paper is divided into two parts: (I) Describes the piezobirefringence experimental apparatus and experimental procedure, sources of error and corrections, the measured values of the piezobirefringence constants (q_{2211}-q_{1111}) and $2q_{1212}$ for the spectral range 4200-7700 A in steps of 100 A, an investigation of the linearity of the stress-optical relationship up to "moderate" pressures, and an investigation of stress-optical hysteresis up to "moderate" pressures. (II) Covers the following: the problem of measuring the absolute values of stress-optical constants q_{1111} and q_{2211}, apparatus and procedure, sources of error, the measured values of the stress-optical constants at 5400 A, the theoretical change in index of refraction under hydrostatic stress, and confirmation of the linearity of the stress-optical relationship up to "moderate" pressures. Strontium titanate was found to become an optically negative uniaxial crystal when stressed along a crystallographic axis and an optically negative biaxial crystal when under a crystallographic diagonal stress. A.

535.555 : 539.234

1637. DOUBLE REFRACTION BY FLUORIDE LAYERS. K.D.Sinel'nikov, I.N.Shklyarevskiĭ and N.A.Vlasenko.
Optika i Spektrosk., Vol. 2, No. 5, 651-7 (1957). In Russian.

It is shown that layers of isotropic substances (CaF_2, BaF_2, LiF, PbS, V_2O_5 etc.) deposited in vacuum by oblique incidence of a molecular beam on a base are optically anisotropic. Double refraction of these layers is due to their porosity and oriented distribution of crystallites. The fluoride layers exhibit biaxial double refraction and the plane of their optical axes coincides with the plane of incidence of the molecular beam. The orientation of the refractive-index ellipsoid relative to the layer surface depends on the angle of incidence of the molecular beam on the base in the process of deposition of the layer. Magnitude of double refraction depends also on this angle of incidence. The biaxial nature of double refraction exhibited indicates that crystallites which form the layers are of complex form. S.Chomet

535.6.08 : 778.6

1638. INSTRUMENT FOR SELECTING VISUALLY NEUTRAL PHOTOGRAPHIC DYE IMAGES. A.J.Sant and O.E.Miller.
J. Opt. Soc. Amer., Vol. 48, No. 1, 4-8 (Jan., 1958).

An instrument has been developed for the systematic visual selection of colour film neutrals. The light source of the instrument accurately simulates a blackbody at 4000°K for this purpose. The visual field of the instrument is circular, bipartite, $4\frac{1}{2}^0$ in visual subtense, and is presented in a dark surround. It is estimated that the source intensity is adequate to insure a stable photopic level of adaptation in the eye of the observer with colour film samples in the beam of visual density as high as 2.50. The instrument can be used: (1) to select neutral film samples as standards for equivalent neutral colour densitometry, (2) to compare the precision with which neutrals may be selected visually by real observers to that associated with the calculation of neutrals from spectrophotometric curves, assuming the characteristics of the C.I.E. standard observer; and (3) to compare the spectrophotometric properties of neutrals selected visually with those of neutrals selected by calculation assuming the C.I.E. standard observer. A.

535.6.08

1639. SOME CONSIDERATIONS REGARDING A METHOD OF ABRIDGED SPECTRORADIOMETRY. D.R.Frankl.
J. Opt. Soc. Amer., Vol. 48, No. 1, 34-6 (Jan., 1958).

A comparative method of abridged spectroradiometry using a detector and two filters is analysed mathematically and two criteria of validity are established. One of these can be tested if the spectral distributions of detector response and filter transmission are known. The other requires, in addition, the knowledge of the maximum difference in spectral energy distributions between the sources being compared. A.

535.68

1640. BAND SYSTEMS FOR APPRAISAL OF COLOR RENDITION. B.T.Barnes.
J. Opt. Soc. Amer., Vol. 47, No. 12, 1124-9 (Dec., 1957).

Chromaticity shifts on the R.U.C.S. scale, for 20% increase in intensity in a single band 0.01 μ wide, were computed for deluxe cool-white and warm-white fluorescent lamps and ten hypothetical pigments with colour points almost uniformly spaced about that of the illuminant. At each wavelength, the colour shift of the most sensitive pigment was taken as a measure of the importance of the spectral flux per 100 A. Seven bands of roughly equal importance in rating cool-white lamps have division points at 0.44, 0.49, 0.53, 0.56, 0.60, and 0.62 μ. For warm-white lamps, the second division point listed above should be omitted. The outer limits of the end bands should be 0.42 and 0.67 μ for ratings based on unweighted energy flux. For comparisons of dissimilar spectral curves, one should weight energy flux within each band in proportion to the maximum shift on the R.U.C.S. scale, per unit increment of spectral flux. This weighting factor has maxima at approximately 0.445, 0.53, and 0.615 μ and minima at 0.49 and 0.56-0.58 μ. Importance in rating deluxe cool-white lamps is only 5 and 8, respectively (average = 100) for Bouma's end bands, 51-195 for the other six, and 73-136 for Kruithof's 7-band system. A.

535.7

PHYSIOLOGICAL OPTICS. VISION. See under "Medical science. Human physiology". Decimal classification 612.84

535.87

1641. METHOD FOR FABRICATING PARABOLOIDAL MIRRORS. G.Hass and J.R.Jenness, Jr.
J. Opt. Soc. Amer., Vol. 48, No. 2, 86-7 (Feb., 1958).

Paraboloidal mirrors were made, using a convex plastic paraboloid formed by centrifugal casting on a mercury surface as the

master for fabricating plastic replica mirrors. Mirrors with disk of confusion diameters less than 1 mm were obtained by the process. A.

535.89 : 612.84

1642. ELECTRONIC MULTIFLASH GENERATOR FOR EXPERIMENTS IN PSYCHOPHYSIOLOGICAL OPTICS.
C.Berger, A.Mahneke and O.Mortensen.
J. Opt. Soc. Amer., Vol. 48, No. 3, 191-2 (March, 1958).

An electronic generator is described which can produce single and several additional light flashes with intensity, light-dark ratio and frequency as independent variables. The duration of the light as well as the dark periods can be adjusted, before starting, manually or automatically by varying the charging current of the condenser in the corresponding circuit, that is the frequency is variable automatically. The additional light flashes can be superimposed during the preceding one, or during the dark interval, or during part of both of them. A.

535.89

1643. MILLIMICROSECOND DURATION LIGHT SOURCE.
J.H.Malmberg.
Rev. sci. Instrum., Vol. 28, No. 12, 1027-9 (Dec., 1957).

A simple circuit utilizing a hydrogen flash-tube is described. The duration of the pulses of light is equal to or less than one millimicrosecond. A.

535.89 : 541.14

EXPLODING WIRE AS A LIGHT SOURCE IN FLASH PHOTOLYSIS. See Abstr. 1360

HEAT

536.212 : 537.311.31

THERMAL CONDUCTIVITY OF ELECTRODEPOSITED CHROMIUM. See Abstr. 1042

536.252 : 538.65

1644. FREE CONVECTION OF HEAT IN MERCURY IN A CLOSED CIRCULAR TUBE IN A TRANSVERSE MAGNETIC FIELD.
A.G.Smirnov.
Dokl. Akad. Nauk SSSR, Vol. 115, No. 2, 284-6 (1957). In Russian.

Liquid mercury is enclosed in vertical or near-vertical glass tubes, heat being transmitted from the lower to the upper end. Heat transmission by conduction, by laminar and by turbulent convection occurs usually simultaneously in different parts of the tube. Transverse magnetic fields of 70-7000 G are applied. The resulting additional forces are readily deduced if the flow is laminar. Experimental results are in agreement, or at least compatible, with the theory. The overall effect of the magnetic field consists in a retardation of the laminar flow and in its stabilization. The temperature gradient determining the onset of turbulence is increased; in weak fields the increase is proportional to the square of the field strength; in stronger fields the increase is proportional to the first power. Eventually a limit of the critical gradient is reached which is independent of any further increase in the field strength. In magnetic fields of this strength laminar flow is altogether suppressed. The experiments do not reveal any effect of the magnetic field on the coefficient of thermal conductivity of mercury. R.Eisenschitz

536.252

1645. STATIONARY CONVECTION IN A PLANE LIQUID LAYER NEAR THE CRITICAL HEAT TRANSFER POINT.
L.P.Gor'kov.
Zh. éksper. teor. Fiz., Vol. 33, No. 2(8), 402-7 (1957). In Russian.

Heat convection which arises above the limit of stability in a plane liquid layer is investigated. A dependence of the motion amplitude on a parameter characterizing the deviation from critical conditions has been obtained. Possible symmetry of the flow is discussed. A.

536.33 : 523.877

1646. DIFFUSION OF RADIATION IN A SEMI-INFINITE MEDIUM. V.V.Sobolev.
Dokl. Akad. Nauk SSSR, Vol. 116, No. 1, 45-8 (1957). In Russian.

The solutions to all the problems on the diffusion of radiation in a semi-infinite medium, which differ in the distribution of the sources of radiation, are shown to be expressible in terms of the same functions $\Phi(\tau)$, which depend only on optical depth. The intensity of radiation is expressed in terms of $B(\tau)$ functions, which lead to the $\Phi(\tau)$ functions, related to the $\phi(\eta)$ functions of Ambartsumyan. Formulae for the $B(\tau)$ functions are obtained for several source distributions and in particular the solution for the problem of the equilibrium of the stellar photosphere is given. M.J.Kearsley

536.33 : 523.877

1647. ON THE GREEN'S FUNCTION OF THE RADIATION DIFFUSION EQUATION. B.A.Veklenko.
Zh. éksper. teor. Fiz., Vol. 33, No. 3(9), 817-19 (1957). In Russian.

It is shown that under the assumptions of Biberman's theory of resonance radiation diffusion (Zh. éksper. teor. Fiz., Vol. 17, 416, 1947), it is possible to obtain analytic expressions for the Green's function for the problem of diffusion of radiation in an infinite medium. For a homogeneous medium the Green's function is given explicitly in the form of an integral and simple asymptotic forms are found for the cases of diffusion of radiation without change of frequency and the dispersion form of a spectral line. M.J.Kearsley

536.33 : 517.948

RADIATIVE TRANSFER PROCESSES. WEINER–HOPF EQUATIONS. See Abstr. 1410

536.42 : 539.893

1648. PHASE DIAGRAM FOR CERIUM.
A.I.Likhter, Yu.N.Ryabinin and L.F.Vereshchagin.
Zh. éksper. teor. Fiz., Vol. 33, No. 3(9), 610-13 (1957). In Russian.

The p–T diagram for cerium of 99.8% purity was obtained for -150° to $+100^{\circ}$ C in a pressure range up to 1200 kg/cm^2. In p–T coordinates the line of phase equilibrium is a straight line with a slope of 43 kg.cm^{-2}.deg^{-1}. It is shown that the transition occuring at atmospheric pressure and low temperatures and the transition at room temperature and high pressures are identical phase transitions. A.

536.421.1 : 537.311.33

CHANGE IN PROPERTIES OF SEMICONDUCTORS ON FUSION. See Abstr. 1047

536.422.15 : 536.71

1649. CALCULATIONS OF SOLID-STATE DATA OF NEON, AND THE VAPOUR PRESSURE RATIO OF ITS ISOTOPES. T.F.Johns.
Phil. Mag. (Eighth Ser.), Vol. 3, 229-36 (March, 1958).

Calculations have been made of the free energies and equations of state of solid Ne^{20} and Ne^{22}, using the method of Henkel. The vapour-pressure ratio of the neon isotopes deduced from the calculated difference in their free energies is in excellent agreement with experimental measurements. Although the molecular volumes of the two isotopes differ by about 0.5%, the vapour-pressure ratio can be calculated quite accurately on the assumption that there is no such volume effect; the reasons for this are explained. A.

536.424 : 537.311.33

PHASE CHANGE IN In_2Se_3. See Abstr. 1692

536.48

1650. ON THE THEORY OF THE LIQUID He-4 PHASE TRANSFORMATION. L.Goldstein.
Ann. Phys. (New York), Vol. 2, No. 3, 177-98 (Sept., 1957).

The previously obtained mean kinetic energy and kinetic heat capacity of saturated liquid He^4 around its phase transformation temperature is used in deriving some qualitative properties of the momentum space distribution function of the liquid atoms. The method is first illustrated through a description of the local momentum space anomalies of ideal Bose–Einstein fluids which are responsible for their macroscopic first-order phase change. The derived liquid He^4 momentum space distribution functions is then applied to predict, within the approximate formalism of the gas kinetic momentum transport mechanism, the qualitative temperature dependence of the viscosity coefficient around the transition temperature. Finally, modifications of various thermal properties of liquid He^4 around its transition temperature are considered on the basis of a third-order type of phase change of liquid He^4, suggested by its recently observed very large, possibly infinite, heat capacity peak. A.

536.48 : 532.133

1651. THE VISCOSITY OF LIQUID HELIUM AT FREQUENCIES OF 11.8 AND 35.5 kc/sec. K.M.Eisele and A.C.H.Hallett.
Canad. J. Phys., Vol. 36, No. 1, 25-34 (Jan., 1958).

A solid cylinder set into torsional oscillation at its natural frequency was used to measure the viscosity of liquid helium in the range of 4.2°K to 1.2°K. Values of the viscosity, calculated from the logarithmic decrement of the decay of the oscillations at the natural frequency of 11.8 kc/s of the cylinder are in good agreement within the errors which are of the order of 30% with the most recent oscillating disk values. Values obtained at a frequency of 35.5 kc/s (a

harmonic of the cylinder) might be of the order of 10% lower. The depth of penetration of the viscous waves in these experiments was less than 5×10^{-5} cm. A.

536.48

1652. THEORY OF KINETIC PHENOMENA IN LIQUID He^3. A.A.Abrikosov and I.M.Khalatnikov.
Zh. éksper. teor. Fiz., Vol. 32, No. 5, 1083-91 (1957). In Russian.

The kinetic coefficients of liquid He^3 were calculated on basis of the theory of a Fermi liquid developed recently by Landau. The temperature dependences of the coefficients and their order of magnitude were determined for two forms of the energy spectrum. A.

536.48 : 536.22

1653. THERMAL CONDUCTIVITY OF LIQUID HELIUM II IN VERY NARROW CHANNELS. K.R.Atkins.
Phys. Rev., Vol. 108, No. 4, 911-13 (Nov. 15, 1957).

Thermal conduction in liquid helium II involves a counterflow of the normal and superfluid components, and in very narrow channels of width 10^{-3} cm or less the dominating factor is the viscosity of the normal component. Near 1°K, however, the phonon mean free path becomes comparable with the channel width and the phonons therefore pass more readily through the channel. This effect is calculated and shown to be in qualitative agreement with the available experimental results, which are not very accurate. A.

536.48

1654. OBSERVATION OF PERFECT POTENTIAL FLOW IN SUPERFLUID. P.P.Craig and J.R.Pellam.
Phys. Rev., Vol. 108, No. 5, 1109-12 (Dec. 1, 1957).

The lift on an airfoil in a velocity field of perfect superfluid flow within liquid helium II was found to vanish for sufficiently low velocity. Thus the flow is pure potential flow with no circulation, and the viscosity boundary condition of zero velocity at the trailing edge (Kutta condition) which is normally introduced does not apply. This is believed to be the first illustration of absolutely perfect hydrodynamic flow, i.e., one in which the viscosity vanishes identically and therefore asserts no influence on the flow field. A.

536.48

1655. BEHAVIOUR OF PARTICLES OF A SMALL EFFECTIVE MASS IN SUPERFLUID HELIUM. R.G.Arkhipov.
Zh. éksper. teor. Fiz., Vol. 33, No. 2(8), 397-401 (1957). In Russian.

The Fokker–Planck method is employed to solve the kinetic equation for the interaction between the thermal excitations and electrons in He II. The electric current density in fields of various strength is determined. A.

536.48

1656. HYDRODYNAMICAL FLUCTUATIONS IN A SUPERFLUID. I.M.Khalatnikov.
Zh. éksper. teor. Fiz., Vol. 33, No. 3(9), 809-11 (1957). In Russian.

In accordance with a theory of Landau and Lifshits (Abstr. 9559/1957) it is assumed that foreign particles which are suspended in a superfluid make contributions to the potential and to the flows of mass, momentum and energy. It is assumed that these contributions are subject to random fluctuations, the rate of which is determined by equations of the Langevin type. From these assumptions the space–time self-correlation functions of the above quantities and some of their cross-correlation functions are deduced. R.Eisenschitz

536.48 : 536.632

1657. THE THERMODYNAMIC FUNCTIONS OF SUPERFLUID HELIUM FILMS. R.G.Arkhipov.
Zh. éksper. teor. Fiz., Vol. 33, No. 3(9), 822-3 (1957). In Russian.

Starting from a theoretical expression for the frequency of surface waves as a function of the wave-vector, the contribution of these waves to the specific heat of helium films is derived. An estimate is made of the film thickness at which surface and bulk contributions are of comparable magnitude. This thickness is found to be reasonably larger than the average wavelength of sound waves thus showing that phonons and surface waves make observable contributions to the specific heat of films. The contribution of the surface waves to the density of the normal fluid component is discussed. R.Eisenschitz

536.48

1658. ON ABSORPTION OF THE SECOND SOUND IN ROTATING HELIUM II. E.M.Lifshits and L.P.Pitaevskiĭ.
Zh. éksper. teor. Fiz., Vol. 33, No. 2(8), 535-7 (1957). In Russian.

Discussing the results obtained by Hall and Vinen (Abstr. 6118, 6119/1957) the authors criticise the use of Born's approximation in deriving scattering cross-sections for collisions of rotons with vortex lines. The present authors apply instead the quasi-classical approximation which they consider to be suited for that particular problem of scattering. The resulting frictional force between superfluid and normal fluid is, however, not in good agreement with experiment. R.Eisenschitz

536.48 : 534.222.1

PROPAGATION OF SOUND ACROSS A BOUNDARY BETWEEN TWO SUPERFLUID PHASES. See Abstr. 1564

536.532 : 537.324

1659. METHODS OF TESTING THERMOCOUPLES AND THERMOCOUPLE MATERIALS. W.F.Roeser and S.T.Lonberger.
Circ. Nat. Bur. Stand., No. 590, 21 pp. (1958).

Various methods used for testing thermocouples and thermocouple materials and the precautions that must be observed in order to attain various degrees of accuracy are described. In particular, the methods that have been developed and used at the National Bureau of Standards are outlined in detail, and some guidance is given to the reader in the selection of the method best adapted to a given set of conditions. Consideration is given primarily to the calibration of platinum versus platinum–rhodium, copper–constantan, chromel–alumel, and iron–constantan thermocouples. A.

536.581

1660. GENERAL PURPOSE IMMERSION CRYOSTAT. N.Fuschillo and D.W.Krautkopf.
Rev. sci. Instrum., Vol. 28, No. 12, 1060-1 (Dec., 1957).

A cryostat is described for temperature control from 300° to −150°C. Novel features of this apparatus include a combined heating-cooling thermal exchange coil, good temperature homogeneity over the experimental volume combined with simplicity in design and ease of demountability and maintenance. By using other bath liquids the range of the cryostat can be extended to higher and lower temperatures. A.

536.628.2

1661. AUTOMATIC TEMPERATURE REGULATION AND RECORDING IN PRECISION ADIABATIC CALORIMETRY. E.D.West and D.C.Ginnings.
Rev. sci. Instrum., Vol. 28, No. 12, 1070-4 (Dec., 1957).

In connection with a precision adiabatic calorimeter used for heat capacity measurements up to 500°C, there is described apparatus for automatically controlling and recording the temperature difference between the calorimeter and its surroundings and for evaluation of the heat leak by electronic integration of the time-temperature difference function. A.

536.631 : 536.48

1662. HEAT CAPACITY OF SODIUM TUNGSTEN BRONZES FROM 1.8 TO 4.2°K. R.W.Vest, M.Griffel and J.F.Smith.
J. chem. Phys., Vol. 28, No. 2, 293-6 (Feb., 1958).

The heat capacity of sodium tungsten bronze (Na_xWO_3) was measured over the temperature range 1.8–4.2°K for various concentrations of sodium. An approximation to the density of states curve for the conduction band was obtained from the experimental data. This may be correlated with the previously described maximum in the electrical conductivity. It was found that the lattice contribution to the heat capacity was appreciably affected by the thermal history of the sample while the electronic contribution was relatively unaffected. A.

536.631 : 538.114

1663. SPECIFIC HEAT OF A FERROMAGNETIC SUBSTANCE ABOVE THE CURIE POINT. C.Domb and M.F.Sykes.
Phys. Rev., Vol. 108, No. 6, 1415-16 (Dec. 15, 1957).

High-temperature expansions for the specific heat of the Ising model are compared for the triangular and f.c.c. lattices. It is concluded that the "tail" of the specific heat curve above the Curie point is much smaller for the f.c.c. lattice, but is steeper in the immediate neighbourhood of the Curie point. For the Heisenberg model for the f.c.c. lattice the tail is larger but apparently much less steep. A.

THERMODYNAMICS

536.7

1664. ON THE SOLUTION OF STEFAN'S PROBLEM LEADING TO A SYSTEM OF ORDINARY DIFFERENTIAL EQUATIONS. V.G.Melamed.
Dokl. Akad. Nauk SSSR, Vol. 116, No. 4, 577-80 (1957). In Russian.

The basic difficulty in solving Stefan's problem for the junction

of two temperature fields arises from the moving boundary conditions which result in non-linear equations. By considering one field alone and taking into account the effect of the second field by means of a restricting function, the Fourier coefficients of the field functions are found to satisfy an infinite set of ordinary differential equations. It is proved that the solution of these is unique and is the limiting case as $n \to \infty$ of $n + 1$ ordinary differential equations obtained by cutting off the Fourier expansions after n terms. The convergence of the solution with increasing n is rapid and is illustrated graphically for n = 1, 2, 3, 4. For practical purposes a good approximate solution is reached already by n = 2.
M.J.Kearsley

536.7

1665. THE REASONS FOR THERMODYNAMICAL IRREVERSIBILITY. B.I.Davýdov.
Zh. éksper. teor. Fiz., Vol. 33, No. 3(9), 811-12 (1957). In Russian.
Rejecting Boltzmann's theoretical approach and ignoring all recent theoretical work,the author asserts that thermodynamical irreversibility originates in the irreversibility of nuclear processes.
R.Eisenschitz

536.71 : 539.893

1666. INVESTIGATION OF THE EQUATION OF STATE BY MEANS OF MECHANICAL MEASUREMENTS. Ya.B.Zel'dovich.
Zh. éksper. teor. Fiz., Vol. 32, No. 6, 1577-8 (1957). In Russian.
The author points out that the use of explosion and shock-wave techniques allows to determine thermodynamic properties at pressures up to 10^6 atm. Experimental results are, in principle, sufficient for expressing the energy as a function of pressure and density. Thermodynamic formulae are compiled to be used for deriving the temperature and entropy in the high-pressure region; for obtaining the absolute entropy it is necessary to identify at least one high pressure adiabatic line at ordinary pressures.
R.Eisenschitz

536.753 : 536.632 : 532.612.4

THERMODYNAMIC PROPERTIES AND HEAT CAPACITY OF MOLTEN Pb, Sn AND In. See Abstr. 1550

ELECTRICITY

ELECTROSTATICS. DIELECTRICS

537.226.1 : 539.2

1667. LATTICE OF PARTLY PERMANENT DIPOLES.
R.A.Toupin and M.Lax.
J. chem. Phys., Vol. 27, No. 2, 458-64 (Aug., 1957).
The electric susceptibility of a lattice of partly permanent dipoles is determined as a function of the temperature and molecular parameters. The calculation is based on the spherical model approximation. The susceptibility has a discontinuous slope at a critical temperature T_C. Numerical techniques are developed for the evaluation of T_C which may have application elsewhere in the statistical theory of lattices. The theory predicts a critical temperature of 98° K for solid hydrogen bromide which corresponds to a measured value of 89° K. A.

537.226.1.08

1668. MEASUREMENT OF THE COMPLEX DIELECTRIC CONSTANT OF LIQUIDS AT CENTIMETER AND MILLIMETER WAVELENGTHS. A.G.Mungall and J.Hart.
Canad. J. Phys., Vol. 35, No. 9, 995-1003 (Sept., 1957).
The measurement of the complex dielectric constant of lossy liquids by a free-space technique is described. The method involves the measurement of absorption per wavelength and of reflectance at normal incidence. Families of curves are given for the relations between these two quantities and the real and imaginary parts of the complex dielectric constant. Results for ethyl and methyl alcohol at 9 and 13 mm wavelength are compared with those obtained by waveguide techniques. A.

537.226.1.08 : 538.082

1669. NOTE ON CAVITY PERTURBATION THEORY.
E.G.Spencer, R.C.LeCraw and L.A.Ault.
J. appl. Phys., Vol. 28, No. 1, 130-2 (Jan., 1957).
A criterion is presented for the applicability of cavity perturbation theory for measuring permeabilities and dielectric constants of materials. In the literature, the perturbation criterion is usually stated as: the r.f. fields in the cavity with and without the sample are approximately equal. This is the same as stating that changes in the stored energy in the cavity, upon introduction of the sample, are small. This criterion is shown to be too strong, and usually violated in experiments. A weaker but sufficient criterion, for all commonly encountered Q values, is that changes in the over-all geometrical configuration of the r.f. fields must be small upon introduction of the sample. Experimentally, this means that for small sample measurements only the percentage change in the real part of the frequency must be small. Data are presented to demonstrate the above ideas. A.

537.226.2

1670. DIELECTRIC LOSS OF AND DEFECTS IN CLAY MINERALS. J.Van Keymeulen and W.Dekeyser.
J. chem. Phys., Vol. 27, No. 1, 172-5 (July, 1957).
The dielectric behaviour of different kaolinites was examined at frequencies ranging from 100 c/s to 20 Mc/s and as a function of the temperature (20°C-300°C). In the tanδ v. frequency curves from all the studied samples, maxima were observed. These maxima are due to a relaxation phenomenon which takes place in the kaolinite lattice. An interpretation of the results is given. A.

537.226.2 : 539.2

1671. DIELECTRIC LOSSES OF DOPED COLORED CRYSTALS. G.Jacobs.
J. chem. Phys., Vol. 27, No. 1, 217-19 (July, 1957).
The dielectric losses of KBr single crystals doped with $BaBr_2$ at different concentrations, both uncoloured and additively coloured, were measured. A maximum in the dielectric loss v. frequency curve in the additively coloured crystal was observed. This relaxation maximum was found to be due to the presence of Z_2 centres. Some remarks are made concerning the activation energies involved. A.

537.226.2

1672. RELAXATION POLARIZATION AND LOSSES IN NON-FERROELECTRIC DIELECTRICS POSSESSING VERY HIGH DIELECTRIC CONSTANTS. G.I.Skanavi, Ya.M.Ksendzov, V.A.Trigubenko and V.V.Prokhvatilov.
Zh. éksper. teor. Fiz., Vol. 33, No. 2(8), 320-34 (1957). In Russian.
It is shown that in polycrystalline dielectrics of the $SrTiO_3$–$Bi_2O_3.nTiO_2$ system relaxation polarization occurs in a broad interval of component concentrations, which leads to a very high permittivity without ferroelectric properties. The nature of relaxation polarization depends on the relative amount of the components. Three groups of strontium–bismuth titanates have been established which differ in composition, crystal structure and other properties. Dielectrics of the first class, which have a perovskite structure, can be divided into two groups possessing various types of relaxation polarization. As shown previously (Abstr. 8759/1956), permittivity of the first group is close to 1000; it attains 6000 for the second group in a fairly broad frequency range. The frequency and temperature dependence of ϵ and tan δ are studied in relation to the composition and structure of the new dielectrics. The experimental results are interpreted from the standpoint of ionic relaxation polarization theory. A.

537.226.2

1673. FERROELECTRICITY OF DICALCIUM STRONTIUM PROPIONATE. B.T.Matthias and J.P.Remeika.
Phys. Rev., Vol. 107, No. 6, 1727 (Sept. 15, 1957).
The water soluble double propionate $Ca_2Sr(CH_3CH_2COO)_6$ has been shown to be ferroelectric, with a Curie temperature at 8.5° C. At −45° C, the spontaneous polarization is 0.3 μ coulomb/cm² and the 60 c/s coercive field 13 kV/cm, both decrease continuously to zero with increasing temperature. L.E.Cross

537.226.2 : 536.424.1

1674. THE EFFECT OF AN ELECTRIC FIELD ON THE TRANSITIONS OF BARIUM TITANATE.
M.E.Drougard and E.J.Huibregtse.
I.B.M. J. Res. Developm., Vol. 1, No. 4, 318-29 (Oct., 1957).
A review is presented of the effects of electric fields on the ferroelectric phase transitions of barium titanate at 120°C and 5°C. The double hysteresis loop observed at the Curie point and the triple hysteresis loop and dielectric constant measured at the 5°C transition are examined in the light of Devonshire's thermodynamic theory of ferroelectricity in barium titanate. The data and various published experimental results are shown to agree with calculations based on the Devonshire free-energy function. The discrepancy between the coercive fields predicted by the theory and those actually observed is discussed. A.

537.226.2

1675. ACTIVATION FIELD AND COERCIVITY OF FERROELECTRIC BARIUM TITANATE. H.H.Wieder.
J. appl. Phys., Vol. 28, No. 3, 367-9 (March, 1957).

The activation field of $BaTiO_3$ c-domain crystals may be calculated from an experimental determination of the frequency dependence of the coercivity. The ratio of activation fields above and below the orthorhombic transition is equal to the respective ratio of coercivities. The decrease in coercivity in passing through this transition is related to the change in thickness of the space charge layer within the ferroelectric. A.

ELECTRIC CONDUCTION. CURRENTS

537.311.31

1676. ELECTRICAL RESISTIVITY OF THE Ni–Pd ALLOY SYSTEM BETWEEN 300°K AND 730°K.
A.I.Schindler, R.J.Smith and E.I.Salkovitz.
Phys. Rev., Vol. 108, No. 4, 921-3 (Nov. 15, 1957).

Electrical resistivity measurements were made on alloys of Ni and Pd from room temperature to 730°K. The maximum in the resistivity was found to shift from 70 atomic % Pd 30 atomic % Ni at room temperature, to the 50–50 composition at temperatures where all the specimens are paramagnetic. At these elevated temperatures it was found that Mathiessen's rule is obeyed over the entire range of compositions. The general behaviour may be interpreted in terms of the dependence of s–d scattering upon temperature and composition. A.

537.311.33 : 537.583 : 621.385.032.213.13

1677. THE LOW-TEMPERATURE CONDUCTIVITY OF OXIDE-COATED CATHODES. G.S.Higginson.
Brit. J. appl. Phys., Vol. 9, No. 3, 106-10 (March, 1958).

Measurements of electrical conductivity in the temperature range 300-700°K employing probe-diodes reveal that, in addition to pore-conduction, at least two conduction processes operate in parallel at temperatures below 700°K. It is suggested that one of these is movement of barium ions over interior crystallite surfaces and the other is electronic conduction limited by electron trapping, e.g. by oxygen, at crystal–crystal interfaces. A.

537.311.33

1678. ELECTRON–HOLE RECOMBINATION STATISTICS IN SEMICONDUCTORS THROUGH FLAWS WITH MANY CHARGE CONDITIONS. Chih-Tang Sah and W.Shockley.
Phys. Rev., Vol. 109, No. 4, 1103-15 (Feb. 15, 1958).

A flaw with s electronic units of negative charge makes transitions to charge $s + 1$ by hole emission at rate $e(p,s)$ or by electron capture at rate $nc(n,s)$ and returns to charge s at rates $e(n,s + 1)$ and $pc(p,s + 1)$. Here n is the electron density in the conduction band and p is the hole density in the valence band. The steady-state ratio of populations N_{S+1} to N_S is given by

$$c(n,s)\,[n + n^*(s + \tfrac{1}{2})]\,/\,c(p,s + 1)\,[p + p^*(s + \tfrac{1}{2})],$$

where $n^*(s + \frac{1}{2}) = e(p,s)/c(n,s)$ and $p^*(s\frac{1}{2}) = e(n,s + 1)/c(p,s + 1)$. This distribution corresponds to an effective Fermi level for the flaws only for the condition of thermal equilibrium. Expressions for the recombination rate based on the steady-state distribution are derived. For a given transition $s \rightleftharpoons s + 1$ the following special cases are defined: (1) denuded: $n < n^*$, $p < p^*$; (2) n-dominated: $n > n^*$, $p < p^*$; (3) p-dominated: $n < n^*$, $p > p^*$; (4) flooded: $n > n^*$, $p > p^*$. Diagrams which aid in visualizing the relative importance of the various transitions are presented. Some speculations on the nature of trapping centres are given. A.

537.311.33 : 538.63

1679. QUANTUM THEORY OF GALVANOMAGNETIC EFFECTS. P.N.Argyres.
Phys. Rev., Vol. 109, No. 4, 1115-28 (Feb. 15, 1958).

A study is made of the effect of the quantization of the electron orbits in a magnetic field on the galvanomagnetic properties of an isotropic semiconductor or semimetal in the phonon-scattering range. The conductivity tensor is calculated using the quantum-mechanical density operator. A generalized Boltzmann equation is derived, in which the scattering for the density matrix elements of interest in the calculation of the current can be described by a relaxation time $\tau(\epsilon)$, that is for most energies inversely proportional to the density of electronic states in the magnetic field. The Hall coefficient and transverse resistivity are studied for a number of different sets of conditions for the electron density, the magnetic field and the temperature. It is found that in all cases the resistivity at very high fields is an increasing function of field. Further the Hall coefficient at high fields does not approach the classical limit. Both Hall coefficient and resistivity under some conditions exhibit an oscillatory dependence on magnetic field. The deviation of the resistivity under some conditions exhibit an oscillatory dependence on magnetic field. The deviation of the resistivity from classical behaviour is easily observable. The deviation of the Hall coefficient is in most cases quite small; however, it may be possible to observe it. A.

537.311.33 : 538.63

1680. MAGNETORESISTANCE IN STRONG MAGNETIC FIELDS. R.Barrie.
Proc. Phys. Soc. B, Vol. 70, Pt 10, 1008-10 (Oct., 1957).

Removes the restrictions $(eh/2\pi mc)\,H \gg kT$, $n = 0$ used in a previous calculation (Abstr. 2195/1957) and obtains an expression for the time of relaxation, which has an oscillatory dependence on H, and for the magnetoresistance. E.P.Wohlfarth

537.311.33 : 621.315.59

1681. SIMPLIFIED TREATMENT OF ELECTRIC CHARGE RELATIONS AT A SEMICONDUCTOR SURFACE. E.O.Johnson.
R.C.A. Rev., Vol. 18, No. 4, 525-55 (Dec., 1957).

Simple, graphical representation is used to describe the electric charge and potential relations at a semiconductor surface. The balance between trapped and mobile charge at the surface is considered for both equilibrium and nonequilibrium situations. The graphical treatment illuminates some of the contemporary surface measuring techniques and shows what happens at metal–semiconductor and gas–semiconductor contacts. P–N junctions, which in a real sense are internal surfaces, are also depicted graphically for both equilibrium and nonequilibrium cases. This treatment serves to emphasize the close similarity between the surface and junction phase-boundary systems, establishing a useful and perhaps novel viewpoint for some aspects of junction behaviour. A.

537.311.33

1682. REMARKS ON THE THEORY OF ELECTRON PLASMA IN SEMICONDUCTORS. V.L.Bonch-Bruevich.
Zh. éksper. teor. Fiz., Vol. 32, No. 5, 1092-7 (1957). In Russian.

The impurity scattering of charge carriers is examined on the basis of the many-electron theory of homopolar semiconductors. The ionization energy of impurity centres due to the third and fifth-group elements is computed. It is shown that at low temperatures plasma screening has an appreciable effect on the nature of scattering. The ionization energy of impurity centres was found to depend on their concentration, decreasing with increase of the latter. A.

537.311.33 : 538.22

1683. MAGNETIC SUSCEPTIBILITY OF SEMICONDUCTORS WITH AN IMPURITY BAND IN A STRONG MAGNETIC FIELD. M.I.Klinger.
Zh. éksper. teor. Fiz., Vol. 33, No. 2(8), 379-86 (1957). In Russian.

Magnetic susceptibility of semiconductors with impurity bands in strong magnetic fields is considered. It is established that for a certain dispersion law the susceptibility rapidly oscillates with increase of the field strength. Since these oscillations substantially depend on the model accepted for the semiconductor with impurity bands their experimental observation may be considered as partial confirmation of the correctness of the proposed model. A.

537.311.33

1684. TEMPERATURE DEPENDENCE OF THE HALL COEFFICIENT IN SEMICONDUCTORS WITH CONSTANT CARRIER CONCENTRATION. E.I.Kaplunova and K.B.Tolpygo.
Zh. tekh. Fiz., Vol. 27, No. 10, 2246-51 (1957). In Russian.

The technique of purifying and preparing homogeneous specimens of certain semiconductors, such as germanium, has attained such a degree of perfection that by measuring the conductivity and Hall coefficient, it is possible to determine with considerable accuracy the concentration of carriers and the temperature variation of the mobility. In this connection consideration is given to the simplest case of the isotropic, quadratic dependence of carrier energy upon velocity in homopolar semiconductors with high mobility when substantial scattering occurs simultaneously at acoustic vibrations and at charged impurities.

537.311.33

1685. GALVANOMAGNETIC EFFECTS IN N-TYPE BISMUTH TELLURIDE. J.R.Drabble, R.D.Groves and R.Wolfe.
Proc. Phys. Soc., Vol. 71, Pt 3, 430-43 (March, 1958).

The resistivity, Hall coefficients and low-field magnetoresistance coefficients associated with current flow in the cleavage planes have been measured at 77°K on a number of n-type specimens of bismuth

telluride. The resistivity and Hall coefficient measurements were extended up to room temperature. The experimental results are given and are shown to be reasonably consistent with a many-valley model of the band structure in which the energy minima are situated on the reflection planes. The parameters associated with this model are evaluated and used to relate the two Hall coefficients to the density of carriers. These relations are used to obtain the conductivity mobility of electrons for current flow in the cleavage planes. This mobility varies as $T^{-1.68}$ over the temperature range 150° K to 300° K and has a value of 1250 $cm^2.sec^{-1}.V^{-1}$ at room temperature. A.

537.311.33 : 541.183.26

1686. OXYGEN SORPTION PHENOMENA ON CADMIUM SELENIDE CRYSTALS. R.H.Bube.
J. chem. Phys., Vol. 27, No. 2, 496-500 (Aug., 1957).

A photostimulated, temperature-dependent, reversible sorption of oxygen on cadmium selenide crystals, pretreated to produce donor centres in the surface layers, was investigated through its effect on the measured dark conductivity. Adsorbed oxygen acts as an acceptor to decrease the surface conductivity at room temperature by at least five orders of magnitude. A.

537.311.33 : 621.315.59

1687. ELECTRON MOBILITY IN THE GERMANIUM–SILICON ALLOYS. B.Goldstein.
R.C.A. Rev., Vol. 18, No. 4, 458-65 (Dec., 1957).

Describes a method for measuring the conductivity mobility of a semiconductor, and an application of this method to the measurement of the majority carrier mobility in the germanium–silicon alloy system. The method involves the determination of charge-carrier densities by means of the voltage dependence of a p–n junction transition capacitance. This technique is particularly suitable to materials with charge-carrier lifetimes too small for drift experiments. Applying the method to the germanium–silicon alloy system, a similar qualitative behaviour has been found for the conductivity and Hall mobilities, as changes are made in alloy composition. However, significant quantitative differences between the measured and calculated values of (μ_H/μ) indicate that some of the assumptions customarily made in calculating scattering factors may not be sufficiently accurate. A.

537.311.33

1688. GROWTH OF SILICON AND GERMANIUM DISKS.
J.R.O'Connor and W.A.McLaughlin.
J. appl. Phys., Vol. 29, No. 2, 222 (Feb., 1958).

Polycrystalline disks about 3/8 in. thick and 3-1/2 in. diameter, were produced by withdrawing from the melt, a disk-shaped seed (initial diameter 1/2 in.) rotating in a vertical plane. Pulling rates of 1/2 in. per hour and rotation rates from 1 to 10 r.p.m. were used. R.Stratton

537.311.33 : 538.63

1689. MAGNETORESISTANCE OF N-TYPE InSb AT 4.2°K.
R.F.Broom.
Proc. Phys. Soc., Vol. 71, Pt 3, 470-5 (March, 1958).

Negative magnetoresistance in n-type InSb at 4.2°K has been investigated for several specimens prepared by different techniques from single crystals of differing purity. The results indicate that this phenomenon is not a bulk property of the material but is largely due to the method of preparation of the specimens. Oscillations in the magnetoresistance as a function of magnetic field have been observed in samples having a balanced donor concentration of less than 10^{16} cm^{-3} and the results are discussed in detail for two samples. A.

537.311.33 : 538.632

1690. HALL EFFECT AND MAGNETO-RESISTANCE IN INDIUM-ANTIMONIDE. G.Fischer and D.K.C.MacDonald.
Phil. Mag. (Eighth Ser.), Vol. 2, 1393-5 (Nov., 1957).

Measurements were made at −12° C, −4° C, 0° C and 26° C with fields up to 40 kG. It is claimed that the results are consistent with simple theory, based on a relaxation time, even though the ratio, of mean free path to orbital radius in the magnetic field, can be as much as ten. R.Stratton

537.311.33

1691. SOME PROPERTIES OF SEMICONDUCTING INDIUM PHOSPHIDE. W.N.Reynolds, M.T.Lilburne and R.M.Dell.
Proc. Phys. Soc., Vol. 71, Pt 3, 416-21 (March, 1958).

Pure polycrystalline samples of indium phosphide have been prepared. Point contact experiments have shown useful rectification on both n- and p-type samples, as well as transistor effects with power gains up to 20 times. The infrared transmission spectrum has been extended to 20 μ, and the effective mass of electrons has been estimated as 0.02 m. Previous work on general properties has been revised and extended. A.

537.311.33 : 536.424

1692. THE INDIUM–SELENIUM SYSTEM.
J.C.Brice, P.C.Newman and H.C.Wright.
Brit. J. appl. Phys., Vol. 9, No. 3, 110-11 (March, 1958).

Polycrystalline specimens of In_2Se_3, InSe and In_2Se were prepared by direct fusion. Electrical and physical measurements were made which indicated a phase change in In_2Se_3 at 196° C. A.

537.311.33 : 538.221

ELECTRICAL ANISOTROPY OF FeS SINGLE CRYSTALS.
See Abstr. 1128

537.311.33

1693. THERMAL CAPTURE OF ELECTRONS IN SILICON.
H.Gummel and M.Lax.
Ann. Phys. (New York), Vol. 2, No. 1, 28-56 (July, 1957).

A theory for thermal transition probabilities of an electron trapped in a semiconductor is developed and applied to capture of electrons by donors in Si. For the interaction of the electron with the lattice vibrations the Bardeen–Shockley deformation potential is used. As the donor ionization energy is less than the Debye energy, acoustic phonons are important and contributions by optical phonons are not taken into account. The calculation is done in the Born–Oppenheimer approximation and only linear terms in the lattice variables for the perturbing operator and the electronic energy levels are kept. Multi-phonon processes are possible if the equilibrium position of the lattice atoms is different for the electronic states between which the transition takes place (Frank–Condon effect). An expansion of the transition probability in terms of the number of participating phonons is given. In Si at low temperatures only one-phonon processes are important and then the Born–Oppenheimer approximation gives the same result that would be obtained using the Born–Hartree approximation. For capture directly into the ground state of donors in Si the energy band structure is of great importance. There are six energy minima, located along the (100) directions. The electronic wave-functions are superpositions of functions belonging to each minimum, these functions being products of Bloch functions associated with the k vectors of the energy minima and solutions of a Wannier equation. Transitions between two wave-functions of this type contain intervalley contributions as well as intravalley contributions. The former are of importance if the vector connecting the two energy minima is about equal to the propagation vector of a phonon having an energy equal to the electronic energy difference between the two states. If the energy minima are located at about three-quarters of the way to the Brillouin zone face, then in Si this condition can best be satisfied for an umklapp process leading from the (100) to the (1̄00) valley. For phosphorus donors this process yields a capture cross-section of $\sigma = |u_f|^2(20/T) \times 10^{-12}$ cm^2, where u_f is the Fourier coefficient of $\exp(iK.r)$ in the expansion of the periodic parts of the Bloch functions and K is the reciprocal lattice vector associated with the umklapp process. It is estimated that $|u_f|^2$ is larger than (1/65). For deep traps, transition probabilities and capture cross-sections are small compared to those for shallow traps. Furthermore, they depend sensitively on the value of the electron–lattice interaction constants and the trapped state wave-function. Relatively small changes in the wave-function can change the calculated capture cross-section by as much as 10^8. The calculated cross-sections are of order 10^{-28} cm^2. A.

537.311.33 : 538.63

1694. WEAK-FIELD MAGNETORESISTANCE IN p-TYPE SILICON. D.Long and J.Myers.
Phys. Rev., Vol. 109, No. 4, 1098-102 (Feb. 15, 1958).

Measurements of the three weak-field magnetoresistance coefficients and the Hall mobility have been made at a number of different temperatures between 77° K and 350° K on p-type silicon samples ranging in resistivity from 0.15 to 115 ohm.cm. The results indicate a marked temperature dependence of the anisotropies of the energy-band structure and/or the scattering. The weak-field magnetoresistance coefficients happen to satisfy nearly the same symmetry relations above about 275° K as those satisfied by n-type germanium. A.

537.311.33

1695. INTRINSIC ELECTRICAL CONDUCTIVITY IN SILICON CARBIDE. J.H.Racette.
Phys. Rev., Vol. 107, No. 6, 1542-4 (Sept. 15, 1957).

Intrinsic electrical conductivity in n-type hexagonal silicon

carbide single crystals was measured. The method of measurement is discussed. The value for the band gap extrapolated to absolute zero, assuming intrinsic conductivity of the form σ = constant $\times e^{-\Delta E/2kT}$, is found to be $\Delta E(0) = 3.1 \pm 0.2$ eV. The conductivity intercept at $T = \infty$ is $(1.3 \pm 0.7) \times 10^4$ $(\text{ohm.cm})^{-1}$.

A.

537.311.33 : 621.315.59

1696. PROPERTIES OF SILICON CARBIDE UNDER THE ACTION OF ELECTRIC PULSES. R.Goffaux.
Rev. gén. Elect., Vol. 66, No. 9, 463-72 (Sept., 1957). In French.

The non-linear behaviour of SiC complexes under the action of very high electric fields, as for example in their use as lightning surge arresters for power lines, has been discussed by Busch and by Teszner. The experiments described here show that the hysteresis observed in the current–voltage characteristic is a function of the duration of the applied high-voltage impulse, being less for shorter pulses. The experimental data can all be explained in terms of a new theory which depends on a new model for the material surrounding the grains of SiC and which is responsible for the intergranular barriers. C.A.Hogarth

537.311.33 : 621.315.59

1697. ELECTRICAL PROPERTIES OF SILICON CARBIDE. INTERPRETATION OF THE DYNAMIC CHARACTERISTIC. THEORY OF NON-OHMIC RESISTANCE. R.Goffaux.
Rev. gén. Elect., Vol. 66, No. 11, 569-76 (Nov., 1957). In French.

For previous work, see preceding abstract. The semiconducting layer around the SiC granules is supposed to contain a series of trapping levels about 0.15 eV below the conduction band and a series of donor centres about 0.35 eV below the conduction band and just above the Fermi level. The time constants for the increase in the carrier concentration on the application of a high field (calculated by the author) is found to agree with values deduced from measurements of Debye absorption. The theory when applied to the small-current part of the V–I characteristic also shows good agreement with the measured d.c. conductance. C.A.Hogarth

537.311.33 : 538.222

1698. MAGNETIC SUSCEPTIBILITY IN TELLURIUM TYPE SEMICONDUCTORS. Yu.A.Firsov.
Zh. tekh. Fiz., Vol. 27, No. 10, 2212-28 (1957). In Russian.

The problem of the magnetic susceptibility in the presence of abutting zones in tellurium type semiconductors is considered. The case where the abutment of the zones is absent but there are some extremes of the function E (k) is investigated. A method is proposed for investigating zonal structure according to the angular relationship of magnetic susceptibility in strong magnetic fields.

537.311.33

1699. Zn_3As_2, A SEMICONDUCTING INTERMETALLIC COMPOUND. G.A.Silvey.
J. appl. Phys., Vol. 29, No. 2, 226-7 (Feb., 1958).

All the samples prepared were p-type with a room temperature resistivity of about 0.2 ohms.cm. Resistance measurements in the intrinsic range and optical absorption measurements at room temperature gave values of 1.1 eV and 1.0 eV respectively for the forbidden energy gap. Rectification was observed with a tungsten point contact. R.Stratton

537.311.33 : 534.135

1700. ON THE MECHANISM OF ELECTROLYTIC RECTIFICATION. A.W.Smith.
Canad. J. Phys., Vol. 35, No. 9, 1151-5 (Sept., 1957).

This new theory assumes that both forward and reverse currents in the oxide film are electronic. Experimental evidence suggests that the currents are determined by the injection of carriers from the electrolyte, the injection of holes when the electrolyte is positive being much more copious than the injection of electrons when the electrolyte is negative. A theory of overvoltage at electrodes is quoted to explain this behaviour of the oxide/electrolyte interface. K.W.Plessner

537.311.33 : 621.382

1701. TRANSISTOR TECHNOLOGY.
Nature (London), Vol. 180, 1329-30 (Dec. 14, 1957).

Report of a conference organized by the Institute of Physics and held at Brunel College, Acton, London, on 27-28 September, 1957. The following papers are noted: D.D.Jones, The effect of physical properties of a semiconductor on device characteristics; W.Bardsley, Defects in transistor materials; J.G.Cressell, Power transistors; J.S.Lamming, A new high-frequency germanium transistor (using the post-alloy diffusion technique); J.T.Kendall, Silicon transistors; J.M.Wilson, The preparation of very high purity silicon (using the crucible-less silane process); A.F.Gibson, Avalanche injection (including a thyratron-like device); D.F.Taylor, Improved junction fabrication (Al alloying technique for Si); and M.Smollett, Germanium photo-transistors. F.F.Roberts

537.311.33 : 537.533.35

EXAMINATION OF P–N JUNCTIONS WITH THE SCANNING ELECTRON MICROSCOPE. See Abstr. 1093

537.312.5

1702. QUANTUM EFFICIENCY OF PHOTOCONDUCTIVE LEAD SULFIDE FILMS. H.E.Spencer.
Phys. Rev., Vol. 109, No. 4, 1074-5 (Feb. 15, 1958).

By using photoconductivity measurements it is shown that the quantum efficiency of lead sulphide films is almost unity. Mobilities calculated from photoconductivity data agree with mobilities obtained from noise and Hall measurements. It is concluded that noise at room temperature is not photon noise. A.

537.312.5 : 535.373

1703. TRAP DISTRIBUTIONS IN CALCIUM TUNGSTATE SINGLE CRYSTALS. J.R.Cook.
Proc. Phys. Soc., Vol. 71, Pt 3, 422-9 (March, 1958).

An investigation has been made of the trap distributions in a single crystal of calcium tungstate as revealed by thermoluminescence and current "glow" curves. The resulting distribution agrees reasonably well with the results of a theoretical analysis of the photocurrent and phosphorescence decays after irradiation with ultraviolet light or gamma-rays from a Co^{60} source. A.

537.312.5 : 537.311.33 : 621.315.5

1704. COMPARISON OF THE SEMICONDUCTOR SURFACE AND JUNCTION PHOTOVOLTAGES. E.O.Johnson.
R.C.A. Rev., Vol. 18, No. 4, 556-77 (Dec., 1957).

It is shown analytically that the surface and junction photovoltages are almost identical phenomena. The functional dependence of the two photovoltages on the light-injected carrier densities is exactly the same, except in the region of saturation. On the other hand, the surface and the junction are basically different with respect to the effect of electric charge changes in traps. These charge changes can have a profound effect on the surface photovoltage but no direct effect at all on the total junction photovoltage. The analysis applies to any type of junction, LH or p–n, and accounts, in distinction to the ordinary diode equation, for saturation effects that stem from changes in the majority carrier concentrations. A possible mechanism for anomalous junction behaviour is briefly discussed. A.

537.312.5

1705. STRUCTURAL PECULIARITIES OF ANTIMONY SULPHIDE LAYERS. V.N.Vertsner, B.V.Gorbunov and Ya.A.Oksman.
Zh. éksper. teor. Fiz., Vol. 32, No. 5, 957-61 (1957). In Russian.

The nature of sensitization processes in Sb_2S_3 layers was investigated by electron diffraction structural studies. It is established that when a layer condenses on a warm base it consists of an amorphous mass of antimony sulphide and a thin surface film of Sb_2O_3. Dependence of the orientation of the small crystals of the oxides produced on the temperature of condensation was determined. It is suggested that the sensitivity of the investigated layers is determined by the crystalline oxide which provides additional capture centres for current-carriers. A.

537.312.5

1706. PHOTOCONDUCTIVITY OF CUPRITE.
A.N.Krongauz, V.K.Lyapidevskii and Yu.S.Deev.
Zh. éksper. teor. Fiz., Vol. 32, No. 5, 1012-17 (1957). In Russian.

Studies of photoconductivity of cuprite under various conditions of illumination were carried out. The light probe method has been used to study the kinetics of photoconductivity at various field strengths and light intensities. Investigation of the temperature dependence of photoconductivity indicates the presence of a peak of negative as well as positive photoconductivity. The combined action of various types of radiation on photoconductivity was studied and it was found that the nature of the observed phenomena depends on the sequence of the illumination processes. A.

537.312.5

1707. THE PROBLEM OF THE TEMPERATURE DEPENDENCE OF PHOTO-E.M.F. F.F.Kodzhespirov.
Zh. éksper. teor. Fiz., Vol. 32, No. 6, 1593-4 (1957). In Russian.

Theoretical expressions are derived for the variation of photo-e.m.f. with temperature. These explain the occurrence of a maximum in experimental curves, which moves to higher temperatures with increasing intensity of irradiation. C.H.L.Goodman

537.312.62

1708. THEORY OF SUPERCONDUCTIVITY.
J.Bardeen, L.N.Cooper and J.R.Schrieffer.
Phys. Rev., Vol. 108, No. 5, 1175-204 (Dec. 1, 1957).

A theory of superconductivity is presented, based on the fact that the interaction between electrons resulting from virtual exchange of phonons is attractive when the energy difference between the electrons states involved is less than the phonon energy, $\hbar\omega$. It is favourable to form a superconducting phase when this attractive interaction dominates the repulsive screened Coulomb interaction. The normal phase is described by the Bloch individual-particle model. The ground state of a superconductor, formed from a linear combination of normal state configurations in which electrons are virtually excited in pairs of opposite spin and momentum, is lower in energy than the normal state by amount proportional to an average $(\hbar\omega)^2$, consistent with the isotope effect. A mutually orthogonal set of excited states in one-to-one correspondence with those of the normal phase is obtained by specifying occupation of certain Bloch states and by using the rest to form a linear combination of virtual pair configurations. The theory yields a second-order phase transition and a Meissner effect in the form suggested by Pippard. Calculated values of specific heats and penetration depths and their temperature variation are in good agreement with experiment. There is an energy gap for individual-particle excitations which decreases from about $3.5kT_c$ at $T = 0^\circ K$ to zero at T_c. Tables of matrix elements of single-particle operators between the excited-state superconducting wave-functions, useful for perturbation expansions and calculations of transition probabilities, are given. A.

537.312.62 : 534.23

1709. SUPERCONDUCTING ENERGY GAP FROM ULTRASONIC ATTENUATION MEASUREMENTS. R.W.Morse and H.V.Bohm.
Phys. Rev., Vol. 108, No. 4, 1094-6 (Nov. 15, 1957).

The ratio α_s/α_n of superconducting to normal attenuation was measured as a function of temperature T for several specimens of Sn and In, at frequencies (28-56 Mc/s) such that the ultrasonic wavelength was small compared with the electronic mean free path. The variation of α_s/α_n with T followed quite closely a form predicted by Bardeen on the basis of the Bardeen–Cooper–Schrieffer theory. It is suggested that such measurements offer a means of finding the variation of energy gap with temperature. R.G.Chambers

537.312.62

1710. SUPERCONDUCTIVITY OF LANTHANUM AND SOME LANTHANUM ALLOYS.
G.S.Anderson, S.Legvold and F.H.Spedding.
Phys. Rev., Vol. 109, No. 2, 243-7 (Jan. 15, 1958).

Superconductivity was observed for two structures of lanthanum. A close-packed hexagonal structure was found to have a transition temperature near $5.0^\circ K$ and the face-centred cubic structure had a transition temperature of $5.95^\circ K$. The initial slope of the H_c–T curve for the face-centred cubic structure was 550 Oe/deg. The transition temperature decreased with decreasing lanthanum content for the La–Y and La–Lu alloys studied. A.

537.312.62

1711. SUPERCONDUCTING TRANSITION OF LEAD.
W.B.Pearson and I.M.Templeton.
Phys. Rev., Vol. 109, No. 4, 1094 (Feb. 15, 1958).

New measurements of the superconducting transition temperature of lead were made, ancillary to the redetermination of the absolute scale of thermoelectric power of this metal. Rather precise measurements on zone-purified lead give a transition temperature of $7.175 \pm 0.005^\circ K$ in zero field which is lower than the previously accepted value of $7.22^\circ K$. The observed transition width was less than 0.001 deg K. A.

537.312.62

1712. STRUCTURE OF SUPERCONDUCTORS. X. THERMAL, MICROSCOPIC AND X-RAY INVESTIGATION OF THE BISMUTH–PALLADIUM SYSTEM. N.N.Zhuravlev.
Zh. éksper. teor. Fiz., Vol. 32, No. 6, 1305-12 (1957). In Russian.

A more exact determination is made of the phase composition of alloys containing 43-45% Pd by weight. The behaviour of the alloys at low temperatures is explained. It is established that increase of the minimal interatomic distances in superconducting compounds of bismuth and palladium leads to an increase in T_c. For previous work see Abstr. 6155 and 7974/1955. A.

537.312.62

1713. STRUCTURE OF SUPERCONDUCTORS. XI. INVESTIGATION OF PLATINUM, RUTHENIUM, OSMIUM AND IRIDIUM ALLOYS OF BISMUTH. N.N.Zhuravlev and L.Kertes.
Zh. éksper. teor. Fiz., Vol. 32, No. 6, 1313-18 (1957). In Russian.

For Pt X see preceding abstract. Two superconducting compounds, BiPt and Bi_2Pt, crystallize in the bismuth–platinum system. The Bi_2Pt compound crystallizes into two (α and β) modifications. The appearance and disappearance of superconductivity in Bi_2Pt alloys can be explained by the existence in the alloys of a high-temperature β-modification — Bi_2Pt. Direct fusion of bismuth with ruthenium, osmium and iridium does not yield compounds of these elements. A.

537.324 : 536.532

METHODS OF TESTING THERMOCOUPLES AND THERMOCOUPLE MATERIALS. See Abstr. 1659

ELECTRIC DISCHARGES

537.521

1714. THEORY OF MOVING STRIATIONS. L.Pekárek.
Phys. Rev., Vol. 108, No. 6, 1371-2 (Dec. 15, 1957).

It is pointed out that previous experiments on moving striations by the author indicate that undamped sinusoidal wave solutions (treated in recent theoretical studies of striations) cannot correctly represent moving striations. A.

537.525

1715. IGNITION OF A HIGH-VOLTAGE DISCHARGE IN HYDROGEN AT HIGH RAREFACTIONS.
A.S.Pokrovskaya-Soboleva and B.N.Klyarfel'd.
Zh. éksper. teor. Fiz., Vol. 32, No. 5, 993-1000 (1957). In Russian.

It is found that in the left branch of the Paschen curve the ignition voltage of a discharge in hydrogen does not satisfy the similarity rules. The high-voltage form of the discharge, which is formed after its ignition in the left part of the Paschen curve, differs by the fact that the potential drop on the electrodes is independent of the current. For a hydrogen discharge this constancy of voltage is valid over a very broad range of currents. If the discharge is produced by voltage pulses of 4 μsec duration, transition from the high-voltage form to arc takes place only at currents exceeding 1000 A. A.

537.525

1716. CONTRIBUTION TO THE THEORY OF A POSITIVE COLUMN IN A LONGITUDINAL MAGNETIC FIELD.
M.V.Konyukov.
Zh. éksper. teor. Fiz., Vol. 33, No. 2(8), 408-11 (1957).
In Russian.

Contraction of a positive column in a gas discharge located in an external magnetic field directed along the discharge axis is considered. A.

X-RAYS

537.531 : 535.331

1717. K-EMISSION SPECTRUM OF METALLIC LITHIUM.
D.E.Bedo and D.H.Tomboulian.
Phys. Rev., Vol. 109, No. 1, 35-40 (Jan. 1, 1958).

The emission spectrum of an evaporated lithium target was investigated in the spectral region extending from 60 to 600 A. The intensity distribution of the characteristic K emission band was determined photometrically. Some features of the distribution $I(E)/\nu^2$ are as follows: the band has a maximum at 54.01 eV (229.50 A); the distribution drops to one-half of its maximum value on the high-energy side at 54.58 eV; and the decay in intensity from the peak to the high-energy limit of the band occurs in an energy interval of 1.18 eV. In agreement with the results of earlier investigators, the band does not show a sharp high-energy cutoff. A second band, similar in shape and having a maximum at 82.83 eV, was observed and is identified as a K satellite. A.

537.531.08 : 621.317.318

1718. PRECISION CHARGE COMPARISON FOR THE STANDARDIZATION OF X-RAY DOSEMETERS.
B.Worthley, A.M.Thompson and M.J.Tooze.
Austral. J. appl. Sci., Vol. 8, No. 4, 261-70 (Dec., 1957).

Two charge comparators based upon Townsend's null method of

charge measurement, and suitable for precision work in standardizing secondary X-ray dosemeters against free air chambers, are described. Electrical charges greater than 10^{-9} C may be compared with an accuracy of approximately 0.03% with this apparatus, the minimum current detectable being 10^{-15} A. A.

CATHODE RAYS. POSITIVE RAYS

537.533 : 621.385.833

1719. ON THE ADIABATIC SELF-CONSTRICTION OF AN ACCELERATED ELECTRON BEAM NEUTRALIZED BY POSITIVE IONS. J.D.Lawson.
J. Electronics and Control, Vol. 3, No. 6, 587-94 (Dec., 1957).

An analysis is made of the behaviour of a space-charge neutralized electron beam under the influence of a longitudinal electric field. The energy lost by radiation and collision is neglected, and transverse velocities are assumed small compared with the drift velocity. It is found that the build-up of the self magnetic field causes the transverse oscillation of the electrons to be damped, but that this damping is counteracted to some extend by an outward diffusion due to multiple scattering of the electrons on the ions. Inductive effects appear as an apparent increase of mass of the electrons. The importance of the problem lies in the fact that such a beam represents a possible intermediate state in setting up a steady-state relativistic beam of the form described by Budker (Proceedings of the C.E.R.N. Symposium on High Energy Accelerators and Pion Physics, Geneva, Vol. 1, 68 (1956) and Atomnaya energiya, Vol. 5, 9, 1956). A.

537.533

1720. BEAM STACKING EXPERIMENTS IN AN ELECTRON MODEL F.F.A.G. ACCELERATOR.
K.M.Terwilliger, L.W.Jones and C.H.Pruett.
Rev. sci. Instrum., Vol. 28, No. 12, 987-97 (Dec., 1957).

A number of experiments are described which test the interactions of particles with r.f. accelerating voltages in an F.F.A.G. accelerator (see Abstr. 7949/1957). The experiments confirm predictions of a theory of Symon and Sessler and demonstrate the feasibility of "stacking" successively accelerated groups of particles with a density close to that of a single group. A.

537.533 : 537.534

1721. TWO-BEAM FIXED FIELD ALTERNATING GRADIENT ACCELERATOR. T.Ohkawa.
Rev. sci. Instrum., Vol. 29, No. 2, 108-17 (Feb., 1958).

An F.F.A.G. accelerator accommodating two beams circulating in opposite directions is proposed. Analytical expressions for the equilibrium orbits and the betatron oscillations are developed and are compared with numerical results obtained by digital computation. Typical design parameters are discussed. A.

537.533.2

1722. A SURVEY OF EXO-ELECTRON EMISSION PHENOMENA. L.Grunberg.
Brit. J. appl. Phys., Vol. 9, No. 3, 85-93 (March, 1958).

"Exo-electron" emission phenomena are reviewed. Kramer's original hypothesis that exo-thermal processes are the cause of the effect is no longer considered valid and it is now widely accepted that peculiarities of the crystal lattice, such as crystal imperfections are present in surfaces showing electron emission after mechanical deformation, X- or ultraviolet irradiation, electron bombardment, etc. Apparently spontaneous emission during phase change of metals requires the presence of surface films. Oxygen must be present for emission to occur after the mechanical deformation of metals and photoelectric emission measurements suggest that certain surface oxides then contain negative-ion vacancies (F'-centres). The emission from ionic materials, such as alkali halides depends on the presence of colour centres. The importance of crystal imperfections is brought out by the parallelism between luminescence and exo-electron emission. The latter depends only on the presence of donor-centres, but not on the activator centres necessary for the former to occur. Various applications of exo-electron phenomena and the question of nomenclature are discussed. A.

537.533.7

1723. A POLARIZATION PROCESS FOR FREE ELECTRONS. S.Yamaguchi.
Naturwissenschaften, Vol. 44, No. 16, 440 (1957). In German.

A triple splitting was observed in an electron beam that had touched the points of a brush of oriented filings of a permanent magnet. This cannot be accounted for by the Lorentz effect, and might be due to polarization by exchange scattering in the magnetic material. J.Hawgood

537.533.7

1724. THE INFLUENCE OF THE ANOMALOUS MAGNETIC MOMENT ON THE SPIN KINEMATICS OF ELECTRONS IN A UNIFORM MAGNETIC FIELD. M.Carrassi.
Nuovo Cimento, Vol. 7, No. 4, 524-35 (Feb. 16, 1958).

The influence of a uniform magnetic field on the spin orientation of electrons, or other spin $\frac{1}{2}$ particles, in a beam is computed by assuming that the Dirac–Pauli equation correctly represents the electrons having anomalous magnetic moment. It is shown that, when the field is orthogonal to the electron beam, the anomalous magnetic moment causes the spin to turn about the field direction faster than in the normal condition. This effect depends on the energy of the electrons and becomes particularly large for energies which are high compared with the rest mass: for about 250 MeV energies a half-circle path in the field would suffice to convert the longitudinal polarization state of the beam into the transverse one. The calculations are performed by making use of the exact solution of the Dirac–Pauli equation. A.

537.533.71 : 537.533.8

1725. INVESTIGATION OF CHARACTERISTIC ELECTRON ENERGY LOSSES AND OF SECONDARY ELECTRON EMISSION FROM GeO_2. N.B.Gornyĭ and A.Yu.Reĭtsakas.
Zh. éksper. teor. Fiz., Vol. 33, No. 3(9), 571-5 (1957). In Russian.

Characteristic energy losses of electrons reflected from the surface of two germanium plates of the n- and p-types covered with GeO_2 were investigated. The spectra of the characteristic losses for both types of plates are very similar. If the difference in the lattice constants is taken into account, the spectra of the characteristic energy losses for GeO_2 and MoO_2, which have identical (tetragonal) lattices,were found to be similar. Secondary electron emission has been investigated for these GeO_2 samples. The secondary electron yield from GeO_2 is almost as large as the yield from germanium. A.

537.533.8 : 539.12

1726. BREMSSTRAHLUNG OF POLARIZED ELECTRONS.
G.L.Vysotskiĭ, A.A.Kresnin and L.N.Rozentsveĭg.
Zh. éksper. teor. Fiz., Vol. 32, No. 5, 1078-82 (1957). In Russian.

The polarization properties of the bremsstrahlung arising when a polarized electron beam strikes a target are considered. It is shown that in this case the bremsstrahlung contains a circularly polarized component. For highly relativistic electrons which are completely polarized in the direction of motion the circular polarization near the upper limit of the spectrum reaches nearly 25%. Multiple scattering of the electrons in the target has almost no effect on this value. Formulae which yield the polarization of bremsstrahlung photons produced by polarized electrons of arbitrary energy have been obtained. A.

537.533.9 : 541.182.6

EFFECT OF ELECTRON BOMBARDMENT ON SILVER IODIDE SOLS. See Abstr. 1363

537.534 : 621.384.61

1727. ELECTROTECHNICAL AND CONSTRUCTIONAL PROBLEMS OF LARGE CYCLIC ACCELERATORS.
F.K.Arkhangel'skiĭ, M.A.Gashev, E.G.Komar, I.F.Malyshev and N.A.Monoszon.
Elektrichestvo, 1957, No. 11, 25-34. In Russian.

A general survey of the principles of cyclic accelerators with special reference to the construction and design of the magnet systems, vacuum chambers, and injection systems. Some comparisons are made between the two American proton synchrotrons and the Russian 10 GeV machine; two photographs of the latter are given. W.O.Lock

537.534

1728. ENERGY STABILIZATION OF THE BERKELEY PROTON LINEAR ACCELERATOR. H.B.Knowles.
Rev. sci. Instrum., Vol. 29, No. 2, 130-6 (Feb., 1958).

A device is described which stabilizes the energy of the 32 MeV proton linear accelerator. The general system is similar to that developed for the Princeton cyclotron, with the exception of the control on the output energy. This control is obtained by slightly detuning the exit end of the r.f. cavity by means of a rotating paddle. Range is used to predetermine the proton energy. An auxiliary circuit is provided for direct control of the correcting paddle. Two ionization-chamber currents are compared by a difference amplifier

which is quite sensitive but very stable and can be located at any distance from the ionization chamber. An energy stabilization of ±40 keV is achieved. A.

537.534

1729. OBSERVATION OF THE DEFLECTED ION BEAM TRAJECTORY FROM A CYCLOTRON.
K.Kimura, J.Kokame and S.Yamashita.
Rev. sci. Instrum., Vol. 29, No. 2, 142-3 (Feb., 1958).

A simple and convenient method is employed to determine the trajectory of the deflected ion beam from a cyclotron. Using several mesh screens across the beam path, the location and angular divergence of the beam in various places can be obtained simultaneously by the holes made by the ion bombardment on these meshes. A.

537.534.1

1730. EQUILIBRIUM DISTRIBUTION OF CHARGE IN A NITROGEN ION [BEAM].
V.S.Nikolaev, L.N.Fateeva, I.S.Dmitriev and Ya.A.Teplova.
Zh. éksper. teor. Fiz., Vol. 32, No. 5, 965-8 (1957). In Russian.

The equilibrium distribution of charge in a beam of nitrogen was determined after traversal of films of beryllium, celluloid, nickel and gold in the energy range from 0.95 to 9.4 MeV. The dependence of the mean charge on the velocity has been obtained. A small difference has been detected in the charge distribution after traversal of various substances by the ions. A.

537.534.3

1731. MASS SPECTROMETER FOR THE STUDY OF ION–MOLECULE COLLISION PROCESSES.
G.F.Wells and C.E.Melton.
Rev. sci. Instrum., Vol. 28, No. 12, 1065-9 (Dec., 1957).

A controlled pressure mass spectrometer for the study of ion–molecule collision processes is described. A pressure ratio of 200 to 1 can be maintained between the ion chamber and the analyser tube by means of differential pumping. Ion beams of the sample gas undergo collision reactions with molecules of the same or other gases in the analyser tube. A.

537.534.7

1732. ON THE APPLICABILITY OF THE PRINCIPLE OF DETAILED BALANCE TO A BEAM OF IONS OF STATIONARY COMPOSITION. Ya.M.Fogel'.
Zh. éksper. teor. Fiz., Vol. 32, No. 3, 604-5 (1957). In Russian.

On the basis of a series of experiments it is shown that the relation $\sigma_{ik}/\sigma_{ki} = N_k/N_i$ (Abstr. 1414/1957) cannot be generally applied in the energy-exchange processes between beams of ions and matter. G.Martelli

537.534.75

1733. DETERMINATION OF THE RANGE–ENERGY RELATION FOR NITROGEN AND OXYGEN IONS IN PHOTOGRAPHIC EMULSIONS. D.M.Parfanovich, A.M.Semchinova and G.N.Flerov.
Zh. éksper. teor. Fiz., Vol. 33, No. 2(8), 343-5 (1957). In Russian.

The dependence of range on energy has been measured for nitrogen and oxygen ions in E-1 Ilford emulsions for energies between 3 to 120 MeV. The results are compared with theoretical predictions. It is also estimated at what energy the nitrogen and oxygen ions lose all their electrons on traversal of matter. A.

537.534.79 : 539.19

1734. THE DISINTEGRATION OF H_2^+, HD^+ AND D_2^+ IONS BY SINGLE COLLISIONS WITH MOLECULES OF HYDROGEN, DEUTERIUM AND AIR. S.E Kupriyanov and V.K.Potapov.
Zh. éksper. teor. Fiz., Vol. 33, No. 7, 311-12 (1957). In Russian.

The relative frequencies of the modes of disintegration of these ions are measured at energy of 3000 eV in gases at 5×10^{-4} mm Hg pressure. They are found to be independent of the scattering gas. G.H.Burkhardt

537.534.8

1735. ON THE EXTRACTION OF ELECTRONS FROM METALS BY FAST MOLECULES. A.M.Furman.
Zh. éksper. teor. Fiz., Vol. 32, No 6, 1591-3 (1957). In Russian.

An extension of a previous paper (Abstr. 7017/1951) showing how the number of electrons extracted may be calculated from a knowledge of certain parameters of the gas and the metal. The O_2/Fe interaction is worked out by way of example. J.B.Arthur

DISCHARGE TUBES. IONIZATION. THERMIONICS

537.561

1736. ADIABATIC CORRELATIONS FOR THE FORMATION OF IONS IN DEGENERATE ELECTRONIC STATES. A.D.Liehr.
J. chem. Phys., Vol. 27, No. 2, 476-7 (Aug., 1957).

The adiabatic correlation theory of McDowell (Abstr. 9337/1954) is modified to include degenerate electronic states. The modified theory is subsequently utilized to determine adiabatic correlations for the ions CH_3^+ and NH_3^+. A.

537.562

1737. CORRELATIONS IN THE CHARGE DENSITY OF A CLASSICAL PLASMA. S.F.Edwards.
Phil. Mag. (Eighth Ser.), Vol. 3, 302-6 (March, 1958).

The charge density of a plasma can be described by the coefficients of its Fourier decomposition. The time correlation of these is calculated in this paper for arbitrary wavelength. The form of the correlation function then varies from that expected from wave motion at long wavelengths, to random perfect gas motion at short wavelengths, and bridges the gap between random short-range motion and ordered long-range effect. A.

537.562

1738. THE MOBILITIES OF IONS IN UNLIKE GASES.
A.Dalgarno, M.R.C.McDowell and A.Williams.
Phil. Trans. A, Vol. 250, No. 982, 411-25 (1958).

The available experimental data on the mobilities at low field strengths of ions in unlike gases are analysed on the basis of a simple theoretical description. Some of the earlier conclusions are modified and the current discrepancies between theory and experiment are emphasized. It is shown that most of the measurements can be explained by classical theory on the assumption that the interaction between an ion and a gas particle is due to the polarization of the gas particle, but that there appears to be a consistent discrepancy of about 8% between theoretical predictions and the series of measurements by the Bristol group. For gases of low polarizability or at high temperatures, the contribution of the repulsive forces must be considered and the case of Li^+ in He is investigated in detail, an interaction being derived from which the observed variation of mobility with temperature may be reproduced. A.

537.562

1739. ON THE BEHAVIOUR OF A COMPLETELY IONIZED PLASMA IN A STRONG MAGNETIC FIELD. S.I.Braginskii.
Zh. éksper. teor. Fiz., Vol. 33, No. 3(9), 645-54 (1957). In Russian.

In the first part of the work some paradoxes are considered which arise when the transfer equations are applied to investigate a quasi-stationary, completely ionized plasma, on the assumption that the collision frequency between the particles is much smaller than their rotation frequency in a magnetic field. In the second part cylindrical plasma pinch is considered in which the plasma pressure is balanced by electrodynamical forces of the current flowing in the pinch. Some solutions of the plasma equations were found for the stationary and non-stationary cases. A.

537.564 : 534.222.2

1740. APPROACH TO EQUILIBRIUM IONIZATION BEHIND STRONG SHOCK WAVES IN ARGON. H.Petschek and S.Byron.
Ann. Phys. (New York), Vol. 1, No. 3, 270-315 (June, 1957).

Previous work on strong shock waves in argon has shown that the degree of ionization reaches thermodynamic equilibrium for shock speeds greater than about ten times the speed of sound in room temperature argon. The degree of ionization reaches about 25% at the highest shock strengths available in an ordinary shock tube. This paper reports a detailed theoretical and experimental study of the approach of high-temperature argon to this equilibrium degree of ionization. The mechanism for the approach to equilibrium can be divided into two stages. The first, which accounts for about 10% of the final ionization, is apparently controlled by impurities present in the gas even after considerable care is taken to insure high purity. No reasonable explanation has been found for the unusual effectiveness of impurities in ionizing argon. In the second stage, ionization by electron–atom collisions becomes dominant. The rate of ionization by this process is limited by the rate of energy transfer to electrons by elastic collisions with the atoms and ions in the gas and is relatively independent of the inelastic ionization

cross-section. This rate is calculated and is in agreement with experimental measurements making use of (1) the visible continuum radiation for the gas, and (2) the electrostatic potentials in the gas due to the diffusion of electrons. A.

537.568

1741. RECOMBINATION COEFFICIENTS FOR POSITIVE AND NEGATIVE IONS. T.H.Y.Yeung.
Proc. Phys. Soc., Vol. 71, Pt 3, 341-6 (March, 1958).

The dielectric constant of an ionized medium is decreased not merely by the presence of electrons but also by that of other free carriers, the positive and negative ions. In a highly electronegative gas discharge, the effect of the ions cannot be neglected and sometimes their contributions may swamp that of the electrons. Under such conditions, measurements of the recombination coefficient between positive and negative ions have been made in the afterglow following pulsed radio-frequency discharges in iodine and bromine vapours. The recombination coefficient α_i was found to be 1.47×10^{-8} cm^3.sec^{-1} for iodine molecular ions and 1.85×10^{-8} cm^3.sec^{-1} for bromine at room temperature. The coefficient α_i was constant over an extended pressure range and was found to be temperature dependent. A.

537.564

1742. ELECTRON IONIZATION CROSS SECTIONS USING CHOPPED BEAMS. R.L.F.Boyd and G.W.Green.
Proc. Phys. Soc., Vol. 71, Pt 3, 351-6 (March, 1958).

The paper describes the development of a crossed-beam method suitable for measuring ionization cross-sections of unstable gases such as atomic hydrogen. Results obtained in He and H_2 are compared with those of Tate and Smith (Phys. Rev., Vol. 39, 270, 1932). The method makes use of a narrow band amplifier associated with a beam chopper and phase sensitive detector, to eliminate the current due to ionization of the background gas. The electric field in the collision region is such that limitation of the beam crossover volume can make the uncertainty in electron energy much smaller than is otherwise possible, without resorting to magnetic collimation or pulsed collection. An analysis of the sources of error due to the collection of spurious currents at signal frequency is given. A.

537.564

1743. ELECTRON ENERGY DISTRIBUTIONS IN UNIFORM ELECTRIC FIELDS AND THE TOWNSEND IONIZATION COEFFICIENT. T.J.Lewis.
Proc. Roy. Soc. A, Vol. 244, No. 1237, 166-85 (1958).

The second-order differential equation which expresses the equilibrium condition of an electron swarm in a uniform electric field in a gas, the electrons suffering both elastic and inelastic collisions with the gas molecules, is solved by the Jeffreys or W.K.B. method of approximation. The distribution function $F(\epsilon)$ of electrons of energy ϵ is obtained immediately in a general form involving the elastic and inelastic collision cross-sections and without any restriction on the range of E/p (electric strength/gas pressure) save that introduced in the original differential equation. In almost all applications the approximations is likely to be of high accuracy, and easy to use. Several of the earlier derivations of $F(\epsilon)$ are obtained as special cases. Using the function $F(\epsilon)$ an attempt is made to relate the Townsend ionization coefficient α to the properties of the gas in a more general manner than hitherto, using realistic functions for the collision cross-section. It is finally expressed by the equation $\alpha/p = A \exp(-Bp/E)$ in which A and B are functions involving the properties of the gas and the ratio E/p. The important coefficient B is directly related to the form and magnitude of the total inelastic cross-section below the ionization potential and can be evaluated for a particular gas once the cross-section is known experimentally. The present theory shows clearly the influence of E/p on both A and B, a matter which has not been satisfactorily discussed previously. The theory is illustrated by calculations of $F(\epsilon)$ and α/p for hydrogen over a range of E/p from 10 to 1000. The agreement between the calculated results and recent reliable observations of α/p is surprisingly good considering the nature of the calculations and the wide range of E/p. A.

537.564 : 539.18

1744. ON THE INTERACTION BETWEEN LITHIUM IONS AND MATTER. Ya.A.Teplova, I.S.Dmitriev, V.S.Nikolaev and L.N.Fateeva.
Zh. éksper. teor. Fiz., Vol. 32, No. 5, 974-8 (1957). In Russian.

The following quantities have been measured for Li^7 ions possessing energies between 0.5 and 5 MeV: specific ionization in hydrogen and air, ranges in hydrogen, air and N.I.K.F.I.-Ya-2 photographic emulsions, and the equilibrium charge distribution after passage through a celluloid film. A.

537.581

1745. THERMIONIC EMISSION FROM A PLANAR TANTALUM CRYSTAL. H.Shelton.
Phys. Rev., Vol. 107, No. 6, 1553-7 (Sept. 15, 1957).

In this investigation two (211) crystals in tantalum ribbon are used as emitter and collector in a three-element retarding-potential experiment. The electrons from one crystal are accelerated through a small aperture which, in conjunction with a strong axial magnetic field, collimates a beam and directs it to the collector crystal. The uniform work-function of single crystals, plane geometry, and the collimating magnetic field completely remove the deleterious effects of conventional retarding-potential experiments that prevent the exact determination of the energy distribution. The resulting retarding-potential plot indicates close agreement with the theoretically predicted two intersecting straight lines on semilogarithmic paper, with the transition region extending less than 20 mV. This indicates a Maxwellian distribution with no large energy-dependent reflection. A slowly varying 6% reflection, as predicted by quantum mechanics, is observed. The temperature, the saturated current density, and the temperature derivative of the work-function, as found from different retarding-potential plots, are used in a Richardson analysis to derive the thermionic constants. For the clean (211) tantalum surface that was used, the work-function, which is practically temperature-independent, is 4.352 ± 0.01 volts, and the emission constant A is 120 amp/cm^2 deg K^2. For differing surfaces resulting from stable layers of foreign adsorbed atoms, the A, as calculated from a Richardson plot, was demonstrated to differ from 120 solely because of the temperature variation of the work-function. A.

537.583 : 621.385.032.213.13

1746. THE PHYSICS OF THE CATHODE. L.S.Nergaard.
R.C.A. Rev., Vol. 18, No. 4, 486-511 (Dec., 1957).

Recent work on thermionic emitters suggests some generalizations bearing on all electron emitters. Four propositions are advanced for consideration and discussion. The propositions are: (1) every cathode is a reducing agent; (2) every cathode lives in equilibrium with its environment; (3) every cathode is a dispenser cathode; (4) monolayer film emitters do not exist. Evidence to support these propositions is adduced. The evidence for the first three propositions is regarded as conclusive. The evidence for the fourth proposition is inconclusive but it suggests that thoriated-tungsten, BaO on tungsten, Ba on tungsten, the L-cathode, the impregnated cathode, and the E-cathode are semiconducting emitters in at least limited temperature ranges. A.

COSMIC RAYS

537.591 : 523.75 : 523.165

INITIAL STAGES IN THE PROPAGATION OF COSMIC RAYS PRODUCED BY SOLAR FLARES. See Abstr. 1451

537.591 : 523.165

ORIGIN AND DYNAMICS OF COSMIC RAYS. See Abstr. 1452

537.591.1

1747. RESEARCH ON COSMIC RAYS — HISTORY AND RESULTS OF RESEARCH ON COSMIC RAYS AT THE COSMIC RAY LABORATORY AT OSAKA UNIVERSITY. Y.Watase, S.Fukui, I.Higashino, K.Suga, K.Hinotani, S.Mitani, Y.Murata, Y.Tanaka and S.Miyamoto.
Annu. Rep. Sci. Works Fac. Sci. Osaka Univ., Vol. 5, 1-49 (1957).

Surveys the work carried out between 1949 and 1956 on the spectrum of μ-mesons and their interactions, penetrating showers and extensive showers, using counters and cloud-chambers.

K.H.Barker

537.591.1

1748. A DETERMINATION OF THE FLUX OF PRIMARY COSMIC PARTICLES IN THE LATITUDE OF 31°N.
K.I.Alekseeva, S.I.Brikker, N.L.Grigorov, F.D.Savin and N.A.Shcherbakov.
Dokl. Akad. Nauk SSSR, Vol. 115, No. 1, 71-4 (1957). In Russian.

The paper consists of a description of a counter telescope used in a study of inelastic interactions of cosmic particles with carbon and hydrogen nuclei (cross-sections to be published later), and of results of measurements of the intensity of the hard component. The authors conclude that the flux of cosmic particles at the top of the atmosphere in the latitude of 31°N is 2.0 cm^{-1}.min^{-1}.sterad^{-1}.

S.Chomet

537.591.1

1749. POLARIZATION OF COSMIC-RAY μ MESONS: THEORY. S.Hayakawa.
Phys. Rev., Vol. 108, No. 6, 1533-7 (Dec. 15, 1957).

The expected polarization of cosmic-ray μ-mesons is calculated on the basis of the two-component theory of the neutrino. The polarization is found to reveal the energy spectrum of π-mesons which decay into μ-mesons at high altitudes, provided that the depolarization on penetration through the atmosphere is known. The depolarization caused by the Coulomb scattering is estimated to be several percent and practically independent of the energy of μ-mesons at production. The depolarization in the absorber is found to be negligible. A.

537.591.1

1750. POLARIZATION OF COSMIC-RAY μ MESONS: EXPERIMENT. G.W.Clark and J.Hersil.
Phys. Rev., Vol. 108, No. 6, 1538-44 (Dec. 15, 1957).

Describes an experimental determination of the polarization of low-energy cosmic-ray μ-mesons at sea level. A brass plate was placed in a horizontal position inside a magnetic solenoid. Particles which arrived from directions near the vertical and stopped in the plate were detected by a coincidence-anticoincidence counter telescope. Stopped negative μ-mesons were destroyed by nuclear capture. Stopped positive μ-mesons decayed into electrons which were detected by delayed coincidence counters placed above and below the plate. The upward and downward fluxes of the decay electrons leaving the absorber were measured alternately with and without a depolarizing magnetic field. The results of the measurements demonstrate that (1) cosmic-ray μ-mesons are polarized, (2) the ratio between the downward fluxes of electrons from the decay of μ-mesons stopped in a brass plate with and without a depolarizing magnetic field is 1.052 ± 0.016, and (3) the indicated polarization of stopped positive μ-mesons is 0.19 ± 0.06 if the data are interpreted according to the two-component neutrino theory of μ-meson decay. The results are consistent with theoretical predictions based on the production spectrum of π-mesons as found in other experiments. A.

537.591.1

1751. PRIMARY COSMIC-RAY PROTON AND ALPHA FLUX NEAR THE GEOMAGNETIC EQUATOR. F.B.McDonald.
Phys. Rev., Vol. 109, No. 4, 1367-75 (Feb. 15, 1958).

The vertical flux of primary protons and of alpha particles was measured at Guam, Marianas Islands ($\lambda = 3^0$ N) using a Cherenkov scintillation detector carried to a residual pressure of 6.1 g/cm^2 by a Skyhook balloon. The primary alpha flux, $J_{o\alpha}$ was found to be, $J_{o\alpha} = 18.0 \pm 2$ particles/m^2.sec.sterad at 0 g/cm^2.atm depth. The flux of primary protons, J_{op} was found to be, as an upper limit (without returning albedo correction), $J_{op} = 115 \pm 12$ particles/m^2.sec.sterad at 0 g/cm^2.atm depth, and as a lower limit (with returning albedo corrections), $J_{op} = 95 \pm 12$ particles/m^2.sec.sterad at 0 g/cm^2.atm depth. This flight completes an extensive latitude survey of the alpha and proton components by this laboratory using identical detectors at all latitudes. The alpha energy spectrum can be represented from 0.150 BeV/nucleon to 7.3 BeV/nucleon by

$$J_{o\alpha}(\geq E) = -(1.5)(415)\int_E^\infty \frac{[1-\exp(-80E')]}{(1+E')^{2.5}}dE'$$

particles/m^2.sec.sterad,

where $J_{o\alpha}(\geq E)$ is the vertical flux of primary alphas with kinetic energy $\geq E$ (measured in BeV/nucleon). This energy spectrum is in excellent agreement with the measured low-energy alpha differential energy spectrum. Above 0.35 BeV/nucleon the alpha energy spectrum is accurately represented by $J_{o\alpha}(\geq E) = 415/(1+E)^{1.5}$ particles/m^2.sec.sterad. The proton energy spectrum in the latitude range 0-41^0 N (15.2-4.0 BeV/nucleon) is well represented by $J_{op}(\geq E) = 6600/(1+E)^{1.5}$ particles/m^2.sec.sterad. Thus the flux of protons and alphas has the same energy dependence over a wide range of energies. Values of the flux of splash albedo at $\lambda = 3^0$ N are given and estimates are made of the magnitude of the returning albedo correction. A.

537.591.1

1752. PROBABILITY OF CHARGE EXCHANGE IN NUCLEONS WITH ENERGIES 3×10^9-10^{10} eV IN INTERACTION WITH AIR. V.A.Vorob'ev.
Zh. éksper. teor. Fiz., Vol. 33, No. 1(7), 264-5 (1957). In Russian.

The probability of charge exchange is evaluated from experimental results on the proton current at various heights and is found to be 0.2 to 0.3. G.E.Brown

537.591.1 : 539.12

EFFECT OF THE ANGULAR VARIATION OF INTENSITY ON SCATTERING DISTRIBUTIONS OF μ-MESONS UNDERGROUND AT A DEPTH OF 40 m W.E. See Abstr. 1181

537.591.15

1753. THEORY OF HIGH-ENERGY N-COMPONENT CASCADES. S.Olbert and R.Stora.
Ann. Phys. (New York), Vol. 1, No. 3, 247-69 (June, 1957).

The longitudinal development of the N component of cosmic-rays is studied theoretically in the extreme relativistic region. The integro-differential equations of the N-component cascades are solved analytically for kernel functions which describe multiple meson production in nucleon–nucleon collisions. It is shown that Fermi's and Landau's models are included in the general solutions as two special cases. Some numerical examples for initial conditions of interest are quoted to demonstrate the mathematical procedure involved. In conclusion, a generalization of the discussed kernel functions is proposed in order to incorporate a possible partial elasticity in high-energy nucleon–nucleon collisions. A.

537.591.15 : 539.17

1754. DEPENDENCE OF THE MULTIPLICITY OF SHOWER PARTICLES ON THE ATOMIC NUMBER OF THE STRUCK NUCLEUS. Zh.S.Takibaev.
Dokl. Akad. Nauk SSSR, Vol. 114, No. 5, 980-3 (1957). In Russian.

Using a technique described earlier (Abstr. 7973/1954), generation of shower particles in Al and W by high-energy cosmic rays in the stratosphere is investigated. The number of stars in both targets (71 in W and 72 in Al) is analysed in terms of the multiplicity of thin and thick (grey and black) tracks and the results are qualitatively discussed. The spectra of recoil nucleons in both metals are also computed and discussed. G.Martelli

537.591.15

1755. ON THE STRUCTURE OF EXTENSIVE COSMIC RAY AIR SHOWERS: LATERAL STRUCTURE OF THE IONIZING COMPONENT. E.W.Kellermann, T.Shaw and G.O.Walker.
Proc. Phys. Soc., Vol. 71, Pt 3, 491-6 (March, 1958).

The lateral distribution of ionizing particles in extensive showers over the approximate range of sizes $5 \times 10^4 < N < 5 \times 10^5$ particles has been studied using a core-locating device to select showers, and unshielded "probing" counter trays to estimate particle density at measured distances from the located shower axis. The distribution is determined with useful accuracy for four ranges of shower size. For the three greatest size ranges examined, the distribution is generally in accord with that of other workers and confirms the observation that for these showers structure does not vary significantly with shower size. For the range corresponding to the smallest showers, which are of a size for which accurate structure measurements have not previously been reported, it is found that the lateral structure shows evidence of significant ageing of the effective cascade. A.

537.591.15

1756. DISTRIBUTION OF THE ELECTRON–PHOTON COMPONENT ON THE PERIPHERY OF EXTENSIVE COSMIC-RAY AIR SHOWERS. S.I.Nikol'skiĭ and V.M.Seleznev.
Zh. éksper. teor. Fiz., Vol. 32, No. 5, 1250-2 (1957). In Russian.

With the help of a large set of counters spread over a great area and connected to a hodoscope (see following abstract) further measurements on the structure of extensive air showers at 3860 m above sea-level were carried out. The spatial distributions were found for: (a) charged particles of extensive showers, generated by primaries with approximate energies 1.6×10^{15} eV, 5×10^{14} eV and 1.6×10^{14} eV respectively; (b) electron–photon component of extensive air showers having 7.4×10^5 and 7.7×10^4 electrons respectively. The above figures refer to distances from the core of the showers ranging up to about 1000 m for (a) and 450 m for (b). Comparison of the experimental results with the formula of Nishimura and Kamata (Progr. theor. Phys., 6, 628, 1951) shows that the spatial distribution of electrons, in showers generated by primaries of $\sim 2 \times 10^{14}$ eV, coincides with the calculated one for $s = 1.2$. For showers generated by primaries of $(1-2) \times 10^{15}$ eV the distributions do not agree, whatever values are taken for s. G.Martelli

537.591.15

1757. INVESTIGATION OF THE PENETRATING COMPONENT OF EXTENSIVE COSMIC-RAY AIR SHOWERS.
Yu.N.Vavilov, Yu.F.Evstigneev and S.I.Nikol'skiĭ.
Zh. éksper. teor. Fiz., Vol. 32, No. 6, 1319-27 (1957). In Russian.

The spatial distribution of μ-mesons in extensive air showers

produced by primary particles of various energies is investigated. It is found that within the accuracy of the measurement the μ-meson spatial-distribution function is independent of the primary-particle energy initiating the shower. The dependence of the number of μ-mesons on particle energy confirms a previous suggestion that the distribution of energy between secondary particles from an elementary nuclear interaction may change at energies of the order of 10^{15} eV. A.

537.591.15 : 539.12

1758. MULTIPLE ELECTRON PRODUCTION IN A HIGH-ENERGY ELECTRON–PHOTON SHOWER.
A.A.Varfolomeev, R.I.Gerasimova and V.A.Tumanyan.
Zh. éksper. teor. Fiz., Vol. 32, No. 5, 969-73 (1957). In Russian.

An unusual electron–photon shower in stratosphere (20/24 km above sea-level) produced by an electron of $> 10^{11}$ eV initial energy was detected in a stack of emulsion layers without backings. Experimental data obtained on the basis of a study of this shower are presented which indicate the occurrence of three cases of simultaneous formation of four electrons (two electron–positron pairs). A.

537.591.15

1759. WILSON CLOUD-CHAMBER INVESTIGATION OF THE ELECTRON–PHOTON COMPONENT OF EXTENSIVE ATMOSPHERIC SHOWERS AT SEA LEVEL.
I.A.Ivanovskaya, G.V.Kulikov, I.V.Rakobol'skaya and L.I.Sarytcheva.
Zh. éksper. teor. Fiz., Vol. 33, No. 2(8), 358-64 (1957). In Russian.

The energy spectra of the electron-photon component in extensive atmospheric showers containing various numbers of particles were measured at various distances from the axis. No dependence of the energy spectra on number of particles in the shower was detected. With increase of the distance from the shower axis the energy spectra become "softer". A significant discrepancy was found to exist between the fraction of high-energy electrons observed experimentally and that computed from cascade theory for various distances from the shower axis. The spatial distribution of the energy carried by the electron-photon component can be approximated by the law γ^{-n} where $n = 2 \pm 0.5$ for shower distances from 2 to 10 metres. A.

537.591.15

1760. SOLUTION OF KINETIC EQUATIONS FOR HIGH-ENERGY NUCLEAR-CASCADE PROCESSES. N.M.Gerasimova.
Zh. éksper. teor. Fiz., Vol. 33, No. 3(9), 637-44 (1957). In Russian.

The altitude dependence of high-energy nuclear-active particles and the spectrum of π-mesons produced in the decay of μ-mesons are investigated. The elementary act is described hydrodynamically; Landau's function, which takes into account a travelling wave in the hydrodynamic solution, is taken as the energy-distribution function of the produced particles. A.

537.591.15 : 539.12

PENETRATING SHOWERS; LIFETIME ESTIMATE FOR Λ^0 AND θ^0 PARTICLES. See Abstr. 1210

537.591.2

1761. ON THE CHARGE AND ENERGY SPECTRUM OF HEAVY PRIMARIES IN COSMIC RADIATION. R.Cester, A.Debenedetti, C.M.Garelli, B.Quassiati, L.Tallone and M.Vigone.
Nuovo Cimento, Vol. 7, No. 3, 371-99 (Feb. 1, 1958).

529 tracks of heavy primaries in cosmic radiation were studied. Charge measurements were carried out on all tracks with a photometric method, and independent checks with gap counting were performed on boron and carbon tracks. All tracks were followed through and a total of 331 nuclear collisions observed. From the analysis of these interactions, the interaction mean free paths and fragmentation probabilities in emulsion and in air were determined. The results are in good agreement with those of other workers and have been used to extrapolate the charge distribution at the top of the atmosphere: the ratios of light nuclei and of heavy nuclei to medium nuclei, at the top of the atmosphere, are 0.30 ± 0.09 and 0.51 ± 0.11 respectively. Results of energy determination on 275 tracks give a value $1.54^{+0.16}_{-0.13}$ for the exponent of the integral energy spectrum. Some difficulties in the application of Peters' relation between the energy of primary and the angles of emission of the fragmentation products are discussed. A.

537.591.8

1762. HEAVY PRIMARY INTERACTIONS IN WATER LOADED EMULSIONS. V.D.Hopper, J.E.Laby and Y.K.Lim.
Nuovo Cimento, Vol. 7, No. 4, 552-64 (Feb. 16, 1958).

Water-loaded emulsions were used to study cut-off energy, spectrum and flux of primary particles at geomagnetic latitude and longitude 47 °S, 135 °W. Results agree with Störmer cut-off energy for the latitude. Most interactions in the water-loaded emulsions were shown to occur in light nuclei. A.

537.591.8 : 539.17

1763. INVESTIGATION OF NUCLEAR DISINTEGRATIONS PRODUCED BY THE CHARGED COMPONENT OF COSMIC RADIATION. T.L.Asatiani and G.V.Khrimyan.
Zh. éksper. teor. Fiz., Vol. 33, No. 3(9), 561-7 (1957). In Russian.

The momentum spectrum of negative π-mesons from stars created by charged cosmic-rays of ~ 30 BeV energy has been obtained. The power exponent of the spectrum is $\gamma = 1.46 \pm 0.2$. The ratio of positive to negative π-mesons is $N_{\pi^+}/N_{\pi^-} = 1.67^{+0.81}_{-0.53}$ and the number of protons produced by particles possessing a momentum $p \geq 10^9$ eV/c is $\sim 30\%$. A.

MAGNETISM

538.082 : 537.226.1

NOTE ON CAVITY PERTURBATION THEORY FOR MEASURING PERMEABILITIES. See Abstr. 1669

538.114 : 548

1764. EFFECT OF CRYSTALLINE ELECTRIC FIELDS ON FERROMAGNETIC ANISOTROPY. W.P.Wolf.
Phys. Rev., Vol. 108, No. 5, 1152-7 (Dec. 1, 1957).

The effect of the electrostatic crystalline field is considered for a magnetic crystal in which the ions are strongly coupled by ferromagnetic exchange. On the basis of the one-ion approximation that the exchange can be represented by a Weiss molecular field, it is possible to derive expressions for the anisotropy constants, $K_i(T)$, in terms of the parameters occurring in the spin Hamiltonian of the isolated ions, and the magnetization of the lattice at the temperature, T. The treatment assumes that the magnetic electrons can be considered as localized on the individual ions, and thus applies primarily to nonmetallic substances such as ferrites. The presence of more than one aligned sublattice is easily taken into account if the magnetization of each sublattice can be calculated from the Néel equations. A.

538.114 : 548

1765. THEORY OF FERROMAGNETIC ANISOTROPY.
W.J.Carr, Jr.
Phys. Rev., Vol. 108, No. 5, 1158-63 (Dec. 1, 1957).

By means of a virial theorem and perturbation theory, the anisotropy energy of a ferromagnetic crystal is expressed in terms of the Coulomb energy alone. This latter energy is approximated by a multipole expansion and the anisotropy constants are given in terms of electric multipole moments and crystalline-potential constants. The multipole moments, which arise from the orbital angular momentum induced by spin-orbit coupling, have been estimated from the known values of angular momentum. The method avoids explicitly carrying out high order perturbations, and furnishes a physical interpretation of the anisotropy mechanism without the use of phenomenological couplings. In most cases, the principal mechanism leading to anisotropy is found to be different from those considered by Van Vleck. A.

538.114

1766. THIN FERROMAGNETIC FILMS. S.J.Glass and M.J.Klein.
Phys. Rev., Vol. 109, No. 2, 288-91 (Jan. 15, 1958).

The spontaneous magnetization of thin films of ferromagnetic materials is studied by means of spin-wave theory. Results are obtained for the magnetization as a function of temperature and film thickness for body-centred and face-centred cubic materials, generalizing earlier calculations by Klein and Smith. The approximations in the theory are critically discussed, and the relevant experimental material is briefly reviewed. A.

538.114

1767. APPROXIMATE THEORY OF FERRIMAGNETIC SPIN WAVES. T.A.Kaplan.
Phys. Rev., Vol. 109, No. 3, 782-7 (Feb. 1, 1958).

The wave-functions and the energy spectrum of the spin-wave problem in a normal spinel are found by means of a straightforward extension of Anderson's approach to antiferromagnetism. Only A–B exchange is assumed to exist, and the calculation is carried to second order in the magnitude of the propagation vector, k. Five distinct energy surfaces (E v. k) are found, two of which are identical, in the classical limit, to the ones previously reported by H.Kaplan. Although the energy surfaces are all spherically symmetric, the wave-functions depend in general on the direction of k. The error

in a calculation by Vonsovski and Seidov, which led to a linear energy v. k relation for the lowest branch (as opposed to the quadratic relation found by H.Kaplan), is pointed out. A.

538.114

1768. ON THE HIGH TEMPERATURE SUSCEPTIBILITY FOR THE HEISENBERG MODEL OF A FERROMAGNETIC.
P.J.Wood and G.S.Rushbrooke.
Proc. Phys. Soc. A, Vol. 70, Pt 10, 765-8 (Oct., 1957).

Series expansions for the susceptibility previously obtained for spin $\frac{1}{2}\hbar$ (Abstr. 2224/1956) are extended to the case of arbitrary spin. Results are given as far as θ^{-6}, where θ = reduced temperature, and these are consistent with previous work (Abstr. 460/1956). A brief discussion is given of some calculations of Curie temperatures. D.J.Oliver

538.114

1769. GENERALIZATION OF THE SPIN-WAVE MODEL TO THE CASE OF SEVERAL ELECTRONS SURROUNDING EACH [LATTICE] SITE. Yu.A.Izyumov.
Zh. éksper. teor. Fiz., Vol. 32, No. 5, 1058-64 (1957). In Russian.

The energy of a weakly excited state of ferromagnetic or antiferromagnetic crystals in which each site is surrounded by several electrons is calculated by the method of approximate secondary quantization applied to a system consisting of two types of interacting Fermi particles. It is found that besides the usual excitations of the ferro-antiferromagnon type some additional excitations appear in these systems which weakly depend on the quasi-momentum. A physical interpretation of the elementary excitations thus found is put forward. A.

538.21

1770. A NEW COLLOID FOR USE WITH THE BITTER FIGURE TECHNIQUE. D.J.Craik and P.M.Griffiths.
Proc. Phys. Soc. B, Vol. 70, Pt 10, 1000-1 (Oct., 1957).

A recipe is given for a colloid which does not stain the metal surface and can thus be used for long periods of observation. D.J.Oliver

538.22 : 537.311.33

MAGNETIC SUSCEPTIBILITY OF SEMICONDUCTORS WITH AN IMPURITY BAND. See Abstr. 1683

538.221

1771. MAGNETIC DOMAIN PATTERNS ON SINGLE-CRYSTAL IRON WHISKERS. R.V.Coleman and G.G.Scott.
Phys. Rev., Vol. 107, No. 5, 1276-80 (Sept. 1, 1957).

Ferromagnetic domain patterns on single-crystal whiskers of pure iron were studied by using the Bitter powder technique. Patterns were observed on both magnetized and unmagnetized specimens and in both cases straightforward interpretations of the patterns can be given. Whiskers with axes along the [111] and [100] directions were studied and observations indicate that crystals with perfect geometry have a very simple domain structure in the unmagnetized state. A.

538.221

1772. MAGNETIC PROPERTIES OF UMn_2.
S.T.Lin and A.R.Kaufmann.
Phys. Rev., Vol. 108, No. 5, 1171-4 (Dec. 1, 1957).

The magnetic properties of UMn_2 were investigated for the temperature range from 360°K down to 4.2°K. Below room temperature the magnetization curves are slightly bent toward the field axis and below 230°K the sample showed a small remanence. The susceptibility against temperature curve shows a λ-type anomaly at 260°K and a steep increase at about 4°K. The hysteresis loops are not symmetrical with respect to the origin and the degree of asymmetry depends upon either the temperature or whether the sample was cooled in magnetic field or without field. From some evidence, UMn_2 is classified as an antiferromagnetic material with a small parasitic ferromagnetism which may arise from uncompensated sublattice moments or uncompensated domain wall magnetization. A.

538.221

1773. SOME MAGNETIC PROPERTIES OF DILUTE ANISOTROPIC FERROMAGNETIC ALLOYS. W.Sucksmith.
Rep. Brit. Elect. Res. Assoc., Rep. N/T74, 7 pp. (1957).

This report is concerned with the magnetic properties of very small particles of iron which are precipitated out of dilute solid solution in copper. An apparatus is described for measuring remanence and coercivity in the very low intensities of magnetization encountered. The work described in Brit. Elect. Res. Assoc. Report N/T64 (1953) has been extended to the development of anisotropic alloys with high coercivities produced by cold drawing of alloys. The results are discussed in the light of existing theories. A.

538.221 : 538.632

1774. ON THE HALL EFFECT IN FERROMAGNETICS.
N.V.Bazhanova.
Zh. éksper. teor. Fiz., Vol. 33, No. 3(9), 567-70 (1957). In Russian.

The Hall effect in Fe—Ni alloys of the "Invar" group was investigated near the Curie temperature. It is found that in ferromagnetics in which technical saturation has been attained the Hall e.m.f. continues to increase linearly with the true magnetization and confirms the validity of formula proposed by Volkov to describe the Hall effect in ferromagnetics. The dependence of the Hall e.m.f. on magnetic field strength obtained on the basis of Ginzburg's equation for true magnetization of ferromagnetics near the Curie point is satisfactorily confirmed by experiment. A.

538.221.08

1775. MAGNETIC ANISOTROPY MEASUREMENT WITH AN OSCILLATION MAGNETOMETER. J.R.Macdonald.
Brit. J. appl. Phys., Vol. 9, No. 3, 116-19 (March, 1958).

A method of using an oscillation magnetometer to determine magnetic anisotropy factors in the plane of a thin disk-shaped sample lying in the X—Z-plane is described. Both the saturation magnetization, M_0 and the factor $(N_X-N_Z)M_0$ may be obtained independently; N_X, N_Y and N_Z are demagnetization factors which include all contributions to magnetic anisotropy such as those arising from stress, magnetocrystalline anisotropy and shape. These results are correlated with previous work on a somewhat different type of oscillation magnetometer used to determine $(N_Y-N_Z)M_0$, and it is shown that a correction must be applied for both types of magnetometer when the oscillation amplitude exceeds a degree or two. Finally, it is shown that the oscillation magnetometer can be employed to determine the details of any angular dependence of magnetic anisotropy in the plane of the sample if such anisotropy is sufficiently large. These measurement techniques are particularly applicable to the determination of any dependence of M_0 on film thickness in thin ferromagnetic evaporated films, and to the determination of magnetic anisotropy in thin films evaporated and/or annealed in a magnetic field. A.

538.222

1776. PARAMAGNETIC PROPERTIES OF DILUTE PALLADIUM—COBALT ALLOYS CONTAINING HYDROGEN.
J.P.Burger and J.Wucher.
C.R. Acad. Sci. (Paris), Vol. 245, No. 25, 2230-3 (Dec. 16, 1957). In French.

Reports results of measurements up to 1000° K of the susceptibility of pure Pd—Co alloys containing 1, 2 and 4% Co; deviations from a Curie—Weiss law were observed. The three alloys containing hydrogen contents up to H/Pd about 0.7 were also investigated, and here the law was found to hold between 100° and 300° K. E.P.Wohlfarth

538.222 : 538.632

1777. HALL EFFECT AND SUSCEPTIBILITY OF GOLD.
N.E.Alekseevskii and Yu.P.Gaĭdukov.
Zh. éksper. teor. Fiz., Vol. 32, No. 6, 1589-91 (1957). In Russian.

Previous work by the same authors (Abstr. 3252/1957) revealed a minimum in the resistance/temperature dependence at ~ 4° K which disappeared in the presence of a magnetic field greater than a critical value, about 8.5 kOe. The variation of Hall voltage with magnetic field has been measured (at 7 temperatures from 0.07 to 295° K), a change of slope being observed in each case at ~ 8.5 kOe. The susceptibility, remaining diamagnetic in the range 1.45-295° K, also increased abruptly at the same field. J.B.Arthur

538.222 : 538.563

1778. EFFECT OF OMNIDIRECTIONAL COMPRESSION ON MAGNETIC PROPERTIES OF ZINC MONOCRYSTALS AT LOW TEMPERATURES. I.M.Dmitrenko, B.I.Verkin and B.G.Lazarev.
Zh. éksper. teor. Fiz., Vol. 33, No. 1(7), 287-9 (1957). In Russian.

538.222 : 537.311.33

MAGNETIC SUSCEPTIBILITY IN TELLURIUM SEMICONDUCTORS. See Abstr. 1698

538.245

1779. MAGNETIC ANISOTROPY AND ROTATIONAL HYSTERESIS IN ELONGATED FINE-PARTICLE MAGNETS.
I.S.Jacobs and F.E.Luborsky.
J. appl. Phys., Vol. 28, No. 4, 467-73 (April, 1957).

Various aspects of the magnetic anisotropy of electrodeposited elongated single-domain Fe and FeCo alloy particles are examined with a view to better understanding their process of magnetization. The initial increase of coercivity with increase of the angle between alignment direction and measuring field is in qualitative accord with

the prediction of the chain-of-spheres model with fanning, as previously proposed, and in contrast to coherent rotation models. Analyses of high-field torque curves and of the fields at which rotational hysteresis vanishes suggest that an anisotropy is present which is a little greater than predicted by the chain-of-spheres model but less than that predicted by the Stoner–Wohlfarth ellipsoid model, for the observed dimensional ratios. Calculations of the rotational hysteresis in single domain-particles are extended to the chain-of-spheres model. A study of the rotational hysteresis enables a relatively sensitive choice between several models of the magnetization process. Comparison of the observed and predicted values for the rotational hysteresis integral, $\int(W_r/I_S)d(1/H)$, indicates strongly that a nonuniform rotation process, like fanning in a chain-of-spheres, is operative in electrodeposited elongated single-domain particles. A.

538.245 : 550.38

1780. THE PROCESS OF MAGNETIZATION BY CHEMICAL CHANGE. G.Haigh.
Phil. Mag. (Eighth Ser.), Vol. 3, 267-86 (March, 1958).

In this paper the well-known processes of magnetization of rocks are discussed and compared and contrasted with the magnetization formed when a ferromagnetic mineral undergoes a chemical change within the influence of an external magnetic field. The thermal stability of the "chemical magnetization" so produced is examined and compared with the magnetizations produced isothermally and thermo-remanently in iron oxides under similar field conditions. The theoretical aspects of such a process of magnetization are considered and the nature of the resulting magnetization is accounted for theoretically. Possible applications in rock magnetic studies are also discussed. A.

538.27

1781. CORRECTION FOR THE FINITE MAGNETIC MODULATION AMPLITUDE IN PARAMAGNETIC AND NUCLEAR MAGNETIC RESONANCE LINES. W.J.Spry.
J. appl. Phys., Vol. 28, No. 6, 660-2 (June, 1957).

A general method of correcting for the finite magnetic modulation amplitude in line shape analyses of paramagnetic or nuclear magnetic resonance lines is described. The method consists of determining the proper "folding" function for the detection system. Once this has been determined, the numerical "unfolding" procedure of A.R.Stokes can be used to compute the true line shape from the observed shape of an arbitrary experimental line. A.

538.27 : 538.562

1782. REMARKS ON THE VOLUME MAGNETOSTRICTION AND THE ANISOTROPIC FORCED MAGNETOSTRICTION. H.Sato.
Phys. Rev., Vol. 109, No. 3, 802-7 (Feb. 1, 1958).

The manner in which the anisotropic forced magnetostriction contributes to the magnetostriction of ferromagnetic substances at high magnetic fields is discussed theoretically. In the past, the isotropic forced volume magnetostriction has been considered to be the only cause of the forced magnetostriction. This is probably one reason for the discrepancies between the experimental value of the volume magnetostriction and the theoretical value expected from the pressure dependence of the Curie point, etc. In addition to this, the limitations of the present theory concerning the relation between the isotropic volume magnetostriction and the related properties mentioned above are briefly examined in connection with the discrepancies between experiment and theory. A.

538.27

1783. THE DE HAAS–VAN ALPHEN EFFECT IN A VARYING MAGNETIC FIELD. A.M.Kosevich.
Zh. éksper. teor. Fiz., Vol. 33, No. 3(9), 735-45 (1957). In Russian.

A theoretical study is made of the characteristic features of the oscillations of the magnetic moment of a metallic sample at low temperatures in a pulsed magnetic field. A.

ELECTROMAGNETISM. ELECTRODYNAMICS

538.3 : 533.7

1784. PROPERTIES OF AN IONIZED GAS OF LOW DENSITY IN A MAGNETIC FIELD. III.
S.Chandrasekhar, A.N.Kaufman and K.M.Watson.
Ann. Phys. (New York), Vol. 2, No. 5, 435-70 (Nov., 1957).

For previous work see Abstr. 3556 (1956). Equations are derived which describe the hydrodynamic properties of an ionized gas in a strong magnetic field and in states close to an initial stationary state. The development is based on the Boltzmann equation in which the effects of collisions between the constituents of the gas are ignored. The theory is, therefore, applicable only for following the evolution of the gas for durations which are short compared to the thermalization time. The method of solution followed is essentially one of expansion in inverse powers of the strength of the impressed magnetic field; and in the first approximation the Boltzmann equation is reducible to a one-dimensional inhomogeneous wave-equation which describes the motions of the particles along the magnetic field lines. A.

538.3 : 532.5

1785. THE PARTITION OF ENERGY IN HYDROMAGNETIC TURBULENCE. S.Chandrasekhar.
Ann. Phys. (New York), Vol. 2, No. 6, 615-26 (Dec., 1957).

The partition of energy between the velocity and the magnetic fields in hydromagnetic turbulence is discussed. It is pointed out that in the framework of a universal theory the discussion must be restricted to the inertial range of eddy sizes which does not include the largest energy containing eddies. On a particular theory of stationary, homogeneous, and isotropic turbulence it is shown that in this inertial sub-range the spectra of the magnetic and kinetic energies are both Kolmogorovian with a constant ratio of amplitudes; further, that in this range, the energy in the magnetic field is 1.6265 times the energy in the velocity field. A.

538.3

1786. ON THE TYPES OF PLASMA OSCILLATIONS IN A MAGNETIC FIELD. S.I.Braginskii.
Dokl. Akad. Nauk SSSR, Vol. 115, No. 3, 475-8 (1957). In Russian.

The plasma oscillations are treated by a general model of two charged ideal gases, the electron and ion gas. This enables the various types of oscillations to be systematized and gives some new results. The fundamental equations are the linearized hydrodynamical equations for the two gases, together with Maxwell's equations. The basic assumption is that the perturbed stress is proportional to the perturbed density of the ideal gas. The equations can be solved, giving the dispersion relations. Solutions are obtained for the limiting cases of high- and low-frequency oscillations for both long and short waves. The results are discussed and compared with the magnetic field free case. P.Roman

538.3 : 532.5

1787. SOME QUESTIONS IN RELATIVISTIC HYDROMAGNETICS. B.Zumino.
Phys. Rev., Vol. 108, No. 5, 1116-21 (Dec. 1, 1957).

The basic equations describing the motion of an ideal relativistic fluid in the presence of electromagnetic fields are formulated both in their differential and in their integral form. From the integral equations shock conditions are derived. In the limit of weak shocks the velocities of propagation of the various kinds of shocks and the discontinuities of the various physical quantities are calculated. A.

538.3 : 532.5

1788. RELATIVISTIC MAGNETOHYDRODYNAMICS. E.G.Harris.
Phys. Rev., Vol. 108, No. 6, 1357-60 (Dec. 15, 1957).

The relativistic equations of motion for a conducting fluid in a magnetic field are formulated. A relativistically correct equation for the production of entropy due to Joule heating is derived from the conservation laws for mass, momentum and energy. It is shown that both the energy density of the magnetic field and the magnetic pressure contribute to the inertia of a perfectly conducting fluid. The general dispersion relation for small-amplitude oscillations is found. A.

538.3 : 532.5

1789. ON MAGNETOHYDRODYNAMIC WAVES AND MAGNETIC TANGENTIAL DISCONTINUITIES IN RELATIVISTIC HYDRODYNAMICS. I.M.Khalatnikov.
Zh. éksper. teor. Fiz., Vol. 32, No. 5, 1102-7 (1957). In Russian.

The problem of magnetohydrodynamic waves in relativistic hydrodynamics is discussed. Formulae are derived which yield the velocity of these waves in the presence of a magnetic field whose direction forms an arbitrary angle with the direction of propagation of the waves in a medium with an arbitrary equation of state. The properties of purely magnetic tangential discontinuities in relativistic hydrodynamics are also discussed. A.

538.3 : 538.566

1790. COHERENT SCATTERING AND RADIATION OF ELECTROMAGNETIC WAVES BY A PLASMA IN A NON-UNIFORM MAGNETIC FIELD. G.A.Askar'yan.
Zh. éksper. teor. Fiz., Vol. 32, No. 6, 1576-7 (1957). In Russian.

Theoretical. The possibility of using localized magnetic fields to increase the scattering efficiency of a plasma is discussed. If the dimensions of the inhomogeneous regions are much smaller than the wavelength of the incident radiation, the scattering is coherent. As an example, the case of a plane wave propagated in a waveguide with an inhomogeneous external magnetic field is considered. The inverse problem is also discussed, namely, the coherent radiation from electrons travelling through a longitudinal periodic magnetic field.
J.B.Arthur

538.3 : 537.562

1791. TRANSPORT PHENOMENA IN A COMPLETELY IONIZED DOUBLE-TEMPERATURE PLASMA. S.I.Braginskii.
Zh. éksper. teor. Fiz., Vol. 33, No. 2(8), 459-72 (1957). In Russian.

A system of transport equations is obtained for a plasma consisting of electrons and one kind of positive ions in electric and magnetic fields. The system includes the continuity equations, equations of motion and equations of heat transport for electrons and ions. The electron and ion temperatures are considered to be different. The case of arbitrary ratio of the particle collision frequency to Larmor frequency is considered. The method of derivation of the transport equations from the kinetic equations is similar to that developed by Chapman and Cowling (The mathematical theory of non-uniform gases, Cambridge, 1939). A.

538.3 : 532.5

1792. ON EQUILIBRIUM MAGNETOHYDRODYNAMICAL CONFIGURATIONS. V.D.Shafranov.
Zh. éksper. teor. Fiz., Vol. 33, No. 3(9), 710-22 (1957). In Russian.

The equilibrium conditions for a bounded system of a conducting gas in a magnetic field are investigated. Equilibrium conditions for thin ring with a helical current are obtained (a) by taking into account gravitational forces,(b) assuming the ring to be surrounded by a gas and (c) assuming an external magnetic field to be present. A correspondence theorem between equilibrium magnetohydrodynamical systems and hydrodynamical vortices is formulated. On basis of this theorem the problem of determining the conditions of equilibrium of magnetohydrodynamic configurations reduces to the theory of steady-state motion of an incompressible liquid. General equilibrium conditions for distributed currents are considered on the assumption of axial symmetry. A.

538.3 : 532.5 : 523.74

HYDROMAGNETIC HEATING EFFECTS. See Abstr. 857

538.3 : 530.145

ELECTROMAGNETIC MULTIPOLE RADIATION. See Abstr. 1495

ELECTROMAGNETIC WAVES AND OSCILLATORS

538.561 : 621.375.9

1793. COMPUTATION OF NOISE FIGURE FOR QUANTUM-MECHANICAL AMPLIFIERS. M.W.P.Strandberg.
Phys. Rev., Vol. 107, No. 6, 1483-4 (Sept. 15, 1957).

An expression is derived for the noise figure for a quantum-mechanical amplifier in terms of the physical quantities describing the electromagnetic structure and the paramagnetic salts — such as gain, circuit Q's, and salt molecular weight and volume. A.

538.561

1794. THEORY OF A THREE-LEVEL MASER. A.Javan.
Phys. Rev., Vol. 107, No. 6, 1579-89 (Sept. 15, 1957).

In a three-level maser, a transition between two energy levels is saturated in order to produce an induced emission of power at a lower frequency corresponding to a transition between an intermediate energy level and one or the other of the two saturated levels. In this paper, certain effects are discussed which cannot be predicted from a theory in which the population differences alone are considered in this process. For instance, it is shown that, in some cases it is possible to obtain for the same system an induced emission of power at two frequencies given by the resonances between the intermediate energy level and both of the saturated levels. Also,it is shown that, even in the absence of inhomogeneous broadening of the spectral line, one can obtain a net induced emission at some portions of a resonant line and a net absorption at other frequencies within the line widths. Such effects become important even in early stages of saturation in cases where $T_1 = T_2$ which is true for ordinary gaseous systems and individual spin systems in a majority of very dilute paramagnetic solids. A complete theory is discussed for a gaseous system and extended to two limiting cases of paramagnetic materials with $T_1 = T_2$ and $T_2 \ll T_1$ for each individual spin system. Furthermore, it is shown that for a saturating field of fixed frequency, the integral of induced power over the entire line is in full agreement with the results of a semiclassical treatment in which the population differences alone are considered. Some remarks are made as to the practicability of certain systems of this type. A.

538.566 : 621.396.677.85

1795. CALCULATED INTENSITY AND PHASE DISTRIBUTION IN THE IMAGE SPACE OF A MICROWAVE LENS. G.W.Farnell.
Canad. J. Phys., Vol. 35, No. 6, 777-83 (June, 1957).

These have been calculated as a preliminary to an experimental determination of the intensity and phase distribution in the diffraction image of a microwave lens. For this the scalar diffraction theory of aberrations as used in optics is assumed to be applicable to a microwave lens. Diagrams show the points of similarity and difference between these and the distributions for optical wavelengths. The corresponding energy flow diagram is given, and this considered with the other diagrams gives an added insight into the formation of the diffraction image of a lens system.
W.T.Blackband

538.566 : 538.3

1796. ON THE SCATTERING OF ELECTROMAGNETIC WAVES IN A PLASMA. A.I.Akhiezer, I.G.Prokhoda and A.G.Sitenko.
Zh. éksper. teor. Fiz., Vol. 33, No. 3(9), 750-7 (1957). In Russian.

Combinational scattering of plasma-density oscillations may occur when electromagnetic waves are propagated in a plasma. The intensity of this scattering is determined in the absence and in the presence of a constant uniform magnetic field. A.

538.566 : 534.222

E.M. SHOCK WAVES. See Abstr. 1562

538.566.3 : 621.396.812.3

1797. THE FADING OF RADIO WAVES REFLECTED AT OBLIQUE INCIDENCE. J.W.King.
J. atmos. terrest. Phys., Vol. 12, No. 1, 26-33 (1958).

Previous experimental results on the reflection of radio waves from the ionosphere at near-vertical incidence have been extended to include the case of waves incident obliquely. It is shown that the radio diffraction pattern formed at the ground by a medium-frequency wave reflected at oblique incidence is very much larger than expected and is, on the average, roughly circular. It is concluded that the ionospheric irregularities responsible for the fading have much greater extent in the horizontal than in the vertical plane. It is found, in general, that the speed of fading of a wave of frequency f is proportional to f cos i, where i is the angle of incidence on the ionosphere, and that the probability distribution of amplitude tends to be log-normal rather than of the type discussed by Rice (Bell Syst. tech. J., Vol. 27, 109, 1947). A.

538.566.3 : 551.510.535

ABSORPTION IN THE F2 REGION OF THE IONOSPHERE. See Abstr. 834

538.566.3 : 551.510.535 : 523.164.83

IONOSPHERIC STUDIES BY THE LUNAR RADAR TECHNIQUE. See Abstr. 854

NUCLEAR AND ATOMIC PHYSICS APPARATUS. PARTICLE DETECTORS

539.1.07

1798. GAS SCINTILLATION COUNTER. A.Sayres and C.S.Wu.
Rev. sci. Instrum., Vol. 28, No. 10, 758-64 (Oct., 1957).

A systematic investigation of the optimum conditions for the design and operation of a gas scintillation counter has been made. The gases studied were xenon, krypton, argon, helium, and various gas mixtures. Both a 6292 and a quartz window K1306 phototube were used with and without quaterphenyl as a wavelength shifter. Under

optimum conditions an energy spread of less than 4% is obtainable for the Po^{210} α particles. The application of the gas scintillation counter as a fast "slow neutron detector", using the reaction $B^{10}(n,\alpha)Li^7$, and its usefulness as a fast fission detector is examined and discussed. A.

539.1.07

1799. THE ČERENKOV EFFECT PRODUCED BY SINGLE PARTICLES IN GASES. A.Ascoli-Balzanelli and R.Ascoli.
Nuovo Cimento, Vol. 6, No. 6, 1392-408 (Dec., 1957).

The problem of the detection by means of photomultipliers of the Cherenkov radiation produced by single particles in gases is studied. It is shown that a high efficiency may be obtained with not too big detectors, provided that each pulse due even to one photoelectron may be detected. Experiments are described, which show that such a use of a photomultiplier is possible, and that an efficiency in agreement with the developed theory has been obtained with an 80 cm long detector filled with air at N.T.P. These experiments allow also a good determination of the number of emitted photons, and the result is in agreement with Tamm's theory. Some results obtained with freon-12 instead of air are also reported. A.

539.1.07

1800. ONE SOME NEW POSSIBILITIES FOR THE DETECTION OF IONS IN METASTABLE LIQUIDS. G.A.Askar'yan.
Zh. éksper. teor. Fiz., Vol. 32, No. 5, 1242-4 (1957). In Russian.

It is suggested that in a solution where the molecules of the solute (gas, vapour or liquid) have a dipole moment much larger than that of the molecules of the solvent, the inhomogeneity created in the microscopic electric field by the passage of a charged particle will favour the concentration of the solute into a very restricted zone around the path of the particle, and a local supersaturation might occur. Under suitable thermodynamical conditions, this might lead to the formation of nucleation centers, on which bubbles might grow. G.Martelli

539.1.07 : 539.12

CLOUD CHAMBER USED FOR MESON DECAY STUDY. See Abstr. 1193

539.1.07

1801. BUBBLE DENSITY IN A PROPANE BUBBLE CHAMBER.
W.J.Willis, E.C.Fowler and D.C.Rahm.
Phys. Rev., Vol. 108, No. 4, 1046-7 (Nov. 15, 1957).

Measurements of the number of bubbles per centimetre in a propane bubble-chamber are described. A method insensitive to the effects which cause inefficiency in direct bubble counting was used, based on the distribution of bubble spacings. The number of bubbles per centimetre measured by using this method is consistent with the rate of delta-ray formation. A.

539.1.07

1802. THE USE OF A MIXTURE OF TWO LIQUIDS FOR A BUBBLE CHAMBER.
G.A.Blinov, Yu.S.Krestnikov, M.F.Lomanov and Ya.Ya.Shalamov.
Zh. éksper. teor. Fiz., Vol. 32, No. 6, 1572-3 (1957). In Russian.

It is suggested that a convenient working temperature can be selected by mixing two liquids in various proportions. Experiments with a mixture of Freon 12 (CCl_2F_2) and Freon 13 ($CClF_3$) confirm this and the sensitive regions found are plotted on a pressure–temperature diagram. W.O.Lock

539.1.07

1803. A NEW MEASUREMENT TECHNIQUE FOR USE IN THE REGION OF THE BLOB-DENSITY MAXIMUM IN NUCLEAR EMULSIONS. B.J.O'Brien.
Nuovo Cimento, Vol. 7, No. 3, 314-19 (Feb. 1, 1958).

The blob density (N_b) is insensitive to changes in ionization in the region of its maximum value. However the density (N_s) of isolated grains, i.e. blobs which are single grains, is found to be useful in this region, and thus the combined techniques of measuring N_b and N_s provide a simple and rapid method of track measurement over the complete range of ionization. An approximate theoretical expression for the variation of N_s with the probability of development is presented. This expression is tested by measurements on tracks of relativistic cosmic-rays over a wide range of charge, and an application of the technique to cosmic-ray studies described. The variation of N_s with the residual range of protons in two emulsions with plateau grain densities of 8 and 20 grains per 100 μm is compared with the corresponding variation of N_b. Possible sources of error in measured values of N_s are found to be similar to those of N_b. A.

539.1.07 : 539.167

LINEAR ACCELERATORS AS RADIOISOTOPE PRODUCERS. See Abstr. 754

539.1.07

1804. AUTOMATIC BRIDGE BALANCE FOR NUCLEAR SPIN RESONANCE SPECTROMETER. R.L.Collins.
Rev. sci. Instrum., Vol. 28, No. 7, 502-3 (July, 1957).

Troublesome changes of the bridge balance in a twin-T nuclear resonance bridge have been eliminated by the application of a voltage-sensitive condenser. A small amplitude, high-frequency modulation voltage applied to the condenser senses any deviation from balance, and a servo loop provides a d.c. correction voltage which maintains the bridge balance. No apparent deterioration of the spectrum results from modulation of the bridge. A.

539.1.07

1805. FIELD STABILIZER FOR HIGH-RESOLUTION NUCLEAR MAGNETIC RESONANCE. H.Primas and H.H.Günthard.
Rev. sci. Instrum., Vol. 28, No. 7, 510-14 (July, 1957).

Theory of design and construction of a field stabilizer for spectrometers is described. Achievable time stability is $1 : 10^8$. A voltage induced by field variation in suitably located coils is amplified by a galvanometer amplifier, integrated, and fed back to a system of coils biasing the field. The feedback ratio is 70 dB from d.c. up to 0.2 c/s. The stabilizer allows measurement of nuclear magnetic resonance signals with resolution of 10^6 under field conditions, independent of field fluctuations produced by temperature variations and stray fields. A.

539.1.07

1806. DOUBLE MODULATION SYSTEM FOR NARROWING ELECTRON RESONANCE ABSORPTION LINES.
R.R.Unterberger, J.L.Garcia de Quevedo and A.E.Stoddard.
Rev. sci. Instrum., Vol. 28, No. 8, 616-19 (Aug., 1957).

A method is presented for observing electron resonance absorption on an oscilloscope screen by using both a magnetic field modulation and a klystron frequency modulation. This is distinguished from the usual system of keeping the klyston frequency fixed and modulating the magnetic field by the fact that the apparent line-width observed on the oscilloscope is narrower than that observable by a single (magnetic or frequency) modulation. An equation is derived relating the apparent line-width (double modulation) to the true line-width (single modulation). Reductions by a factor of 17 can be easily obtained. As a result paramagnetic absorption lines ordinarily too wide to be observed within the width of the resonant cavity containing the sample can be observed within the cavity resonance. It is believed that this double modulation system might be advantageous in oscilloscope searching for new paramagnetic absorptions. A.

539.1.07

1807. NUCLEAR RESONANCE PULSE APPARATUS.
J.C.Buchta, H.S.Gutowsky and D.E.Woessner.
Rev. sci. Instrum., Vol. 29, No. 1, 55-60 (Jan., 1958).

Radiofrequency pulse apparatus is described for nuclear magnetic and pure quadrupole spin-echo and free induction decay experiments in the 15 to 42 Mc/s frequency range. Nuclear spin relaxation times between 20 μsec and 50 sec have been measured with the apparatus. Simple cryostats provide temperatures from 100° to 500°K. A.

ELEMENTARY PARTICLES

539.12

1808. MATRIX ALGEBRA OF THE THEORY OF SPIN 3/2 PARTICLES. É.E.Fradkin.
Dokl. Akad. Nauk SSSR, Vol. 115, No. 5, 907-10 (1957). In Russian.

The basic relations of the algebra for the matrices related to the wave equation of particles of unique spin value 3/2 and positive definite total charge are set up. The general algebraic conditions are found to be too wide, and the suitable restrictions are obtained by taking into account the necessity of formulating bilinear Hermitian invariants and the subsidiary conditions which the wave-function has to satisfy in the presence of an electromagnetic field. P.Roman

539.12 : 530.145

1809. ANOMALOUS EQUATIONS FOR SPIN 1/2 PARTICLES. I.Ulegla.
Zh. éksper. teor. Fiz., Vol. 33, No. 2(8), 473-7 (1957). In Russian.

New irreducible relativistic wave-equations for spin 1/2 particles are deduced. They differ from the Dirac equations. The particles described by these equations may have one or more proper masses

and the corresponding fields have a positive definite charge density. The existence of such equations is not incompatible with the well-known proof of uniqueness of the Dirac equations. A.

539.12

1810. SOME REMARKS ON WEAK PROCESSES OF ELEMENTARY PARTICLE TRANSFORMATION.
L.Okun' and B.Pontekorvo [Pontecorvo].
Zh. éksper. teor. Fiz., Vol. 32, No. 6, 1587-8 (1957). In Russian.

Consequences of allowing processes with $|\Delta S| > 1$ to have probability comparable to those of $|\Delta S| = 1$ are considered. In particular, this would predict the emission of hyperons by hyperfragments, and a larger mass difference between K_1^0 and K_2^0-mesons.

G.E.Brown

539.12

1811. ON THE ENERGY DISTRIBUTIONS IN TWO-PARTICLE DECAY REACTIONS. G.I.Kopylov.
Zh. éksper. teor. Fiz., Vol. 33, No. 2(8), 430-41 (1957). In Russian.

Isotropic decay into two particles is examined in the laboratory system. It is shown that the distribution of the secondary particles in ν, a parameter defined in the paper, possesses a number of simple properties ("symmetry properties") which are independent of the energy distribution of the primary particles. Formulae are presented which permit one to determine the ν-spectrum of one secondary particle and of the primary particle knowing that spectrum for the other secondary particle. Symmetric properties of the spectrum of cascade-decay products are also demonstrated. By a simple recalculation analogous formulae for the energy spectra can be obtained. When the angular distribution is taken into account these formulae are approximately valid for the high-energy part of the spectrum. Along with qualitative applications it is possible to use the derived equations for identification of the primary particles by their mass and for establishing the isotropy or cascade nature of the decay. A.

539.12

1812. DETERMINATION OF THE MASSES OF SLOW CHARGED PARTICLES IN PHOTOGRAPHIC EMULSIONS. M.I.Tret'yakova.
Zh. éksper. teor. Fiz., Vol. 32, No. 6, 1280-93 (1957). In Russian.

The accuracy of various methods of determination of the masses of slow charged particles stopped in photographic plates is examined. It is shown that for reliable identification of an individual particle it is not sufficient to determine its mass by only one method. Distributions in mass of slow charged particles ($E<30$ MeV) produced by ~460 MeV protons are presented which were obtained by using different methods of mass determination. The mass and charge-sign distributions have been obtained by the magnetic deflection–range method for slow particles ($E<50$ MeV) created by cosmic rays at an altitude of ~9.5 km. A.

539.12 : 530.145

ON THE MASS SPECTRUM OF ELEMENTARY PARTICLES. See Abstr. 1503

539.12 : 530.145

1813. ON SOME ELECTROMAGNETIC EFFECTS INVOLVING STRONGLY INTERACTING PARTICLES. L.M.Afrikyan and G.M.Garibyan.
Zh. éksper. teor. Fiz., Vol. 33, No. 2(8), 425-9 (1957). In Russian.

Some electromagnetic effects involving strongly interacting particles are considered. The calculations are carried out within the framework of quantum electrodynamics by introduction of form factors. It is shown that the considered effects can be used to obtain information on the structure and properties of strongly interacting particles. A.

539.12 : 530.145

CASCADES OF SEVERAL TYPES OF PARTICLES. See Abstr. 1527

539.12

1814. THE RADIATION OF CHARGED PARTICLES IN FLIGHT NEAR PERFECTLY CONDUCTING BODIES.
Yu.N.Dnestrovskiĭ and D.P.Kostomarov.
Dokl. Akad. Nauk SSSR, Vol. 116, No. 3, 377-80 (1957). In Russian.

The radiation of a point charge in flight near an axially symmetric perfectly conducting surface is studied in the non-relativistic approximation, when the problem can be separated into two parts. The induced charge and current are first calculated without taking retardation into account, and next the radiation due to the found current system is calculated. Using the dipole approximation, expressions are found for the rate at which energy is radiated. The results are generalized to a group of electrons moving with constant velocity. The radiation resistance of the system is calculated and graphs are given showing its dependence on the velocity of the particles and on the wavelength of the radiation. M.J.Kearsley

539.12

1815. THE ČERENKOV EFFECT IN COMPOSITE (ISOTROPIC) MEDIA. A.M.Sayied.
Proc. Phys. Soc., Vol. 71, Pt 3, 398-404 (March, 1958).

The Cherenkov radiation emitted by a fast charged particle moving through one medium and in the vicinity of another medium has been theoretically investigated, employing the invariance of the phenomenological electrodynamic equations of Maxwell. A simple geometry has been considered, this being the case of two coaxial dielectrics and permeable cylinders with a common cylindrical interface and a charged particle moving along their common axis. The results obtained have been discussed with special reference to the case of Cherenkov radiation at microwave and radiofrequency regions. The effect of the phenomena of coherence on the output of the emitted radiation in these cases has been briefly outlined. A.

539.12

1816. UNITARITY RELATIONS FOR ELASTIC SCATTERING OF PARTICLES WITH AN ARBITRARY SPIN.
R.M.Ryndin and Ya.A.Smorodinskiĭ.
Zh. éksper. teor. Fiz., Vol. 32, No. 6, 1584-5 (1957). In Russian.

A generalization of the optical theorem is obtained for particles with spin. G.E.Brown

539.12

1817. ON THE PHASE OF A SCATTERED WAVE. F.S.Los'.
Zh. éksper. teor. Fiz., Vol. 33, No. 1(7), 273-4 (1957). In Russian.

A particular form of the variation-of-constants method is applied to the scattering of a particle by a spherically symmetrical potential. G.E.Brown

539.12 : 530.145

SCATTERING OF PARTICLES OF ARBITRARY SPIN. See Abstr. 1526

539.12 : 530.145

POLARIZATION OF DIRAC PARTICLES IN SCATTERING. See Abstr. 1529

539.12 : 538.3

1818. ON THE DIFFUSION OF CHARGED PARTICLES IN A HOMOGENEOUS ELECTROMAGNETIC FIELD. Kh.Ya.Khristov.
Dokl. Akad. Nauk SSSR, Vol. 116, No. 2, 213-16 (1957). In Russian.

The equations governing the behaviour of charged particles diffusing in a homogeneous unchanging medium in a homogeneous electromagnetic field, developed in the author's previous papers (Acta phys. Hungar., Vol. 7, 51, 67, 1957; Abstr. 5846/1957; Zh. éksper. teor. Fiz., to be published) are studied in detail. In the equations, particles may not only be scattered, but also absorbed and may generate new particles. Solutions are found for the case of zero electric field and a method is sketched for finding approximate solutions with a non-zero electric field. M.J.Kearsley

539.12

1819. SCATTERING OF PHOTONS BY PROTONS.
A.M.Baldin and V.A.Petrun'kin.
Zh. éksper. teor. Fiz., Vol. 32, No. 6, 1570-2 (1957). In Russian.

Using the unitarity and symmetry of the S-matrix, relations between matrix elements for the scattering and those for the photoproduction of mesons are derived. Experiments necessary to determine all parameters are discussed. G.E.Brown

539.12

1820. CONCERNING RESONANCE SCATTERING OF γ-RAYS.
N.A.Burgov.
Zh. éksper. teor. Fiz., Vol. 33, No. 3(9), 655-9 (1957). In Russian.

Experiments are suggested for determination of the width of excited levels and (if the experiments are of sufficient duration) the correlation constants between the electron and neutrino, λ, and consequently to elucidate the problem of the type of force involved in β-disintegration. A.

539.12

1821. REFLECTION OF γ-RADIATION FROM BENT QUARTZ PLATES. O.I.Sumbaev.
Zh. éksper. teor. Fiz., Vol. 32, No. 6, 1276-9 (1957). In Russian.

The wavelength dependence of the coefficient of reflection from the $13\bar{4}0$ planes of a quartz crystal bent along a cylinder with a radius of two meters was studied on a two-metre crystal-diffraction gamma-spectrometer. The quadratic character of the dependence

is confirmed. It is shown that in the theoretical treatment of the effect the curvature of the reflecting planes should be taken into account. The plate is divided into a number of independent reflecting layers, the thickness of each of which is smaller than the distance of primary extinction and behaves like a mosaic crystal with a small primary extinction. Thus the hitherto inexplicable fact of a quadratic dependence of the reflection coefficient on wavelength can be explained in a natural way. A.

539.12 : 539.17

1822. THE ABSORPTION OF HIGH-ENERGY PHOTONS IN MATTER. J.Moffatt, J.J.Thresher, G.C.Weeks and R.Wilson.
Proc. Roy. Soc. A, Vol. 244, No. 1237, 245-58 (1958).

Total absorption cross-sections of hydrogen, carbon, copper, silver, lead and uranium have been measured for photons of mean energy 94 MeV. The method was to measure the transmission through an absorber of photons from the Oxford synchrotron, using a biased liquid scintillation counter to select photons of energy near the peak energy of the machine. The experimental data for hydrogen have been used to deduce a value for the cross-section for pair production in the field of the electron of 4.7 ± 0.4 millibarn. The relative cross-sections for the heavier elements have been determined to better than ±0.2%, and confirm the most recent calculations of the correction to the Born approximation in the theory of pair production. A.

539.12 : 530.145

1823. ON THE THEORY OF THE NEUTRINO WITH ORIENTED SPIN. A.Sokolov.
Nuovo Cimento, Vol. 7, No. 2, 240-3 (Jan., 1958).

The Dirac equation for a free particle is shown to possess, for the case of zero mass, only two independent solutions for a given momentum. These are interpreted as the states of the neutrino (with spin parallel to the momentum) and of the antineutrino (with spin antiparallel to its momentum). For finite rest-mass, it is shown that there are again four states. [The results developed in this letter appear to be already contained in the papers of Landau (Abstr. 6901/1957) and Lee and Yang (Abstr. 3956/1957)]. P.K.Kabir

539.12

1824. "TWIN" NEUTRINOS: A MODIFIED TWO-COMPONENT THEORY. M.G.Mayer and V.L.Telegdi.
Phys. Rev., Vol. 107, No. 5, 1445-7 (Sept. 1, 1957).

To overcome certain discrepancies between experiment and the predictions of conventional 2-component neutrino theory, a "twin neutrino" theory is proposed. In the more general formulation of this theory, two different 2-component neutrinos ν_1, ν_2 of opposite screw-sense are introduced, together with their antiparticles $\bar{\nu}_1$, $\bar{\nu}_2$. In beta decay, one of these is coupled by T and V interactions, the other by S and A interactions. This eliminates all interference terms. The theory is then specialized to the assumption $\bar{\nu}_1 \equiv \nu_2$, i.e., to Majorana-type neutrinos. This more restricted theory is equally successful in explaining the results of the "parity experiments". It is shown that the conventional objections to the Majorana theory need not apply to this twin-neutrino theory. A.

539.12 : 530.12

1825. INTERACTION OF NEUTRINOS AND GRAVITATIONAL FIELDS. D.R.Brill and J.A.Wheeler.
Rev. mod. Phys., Vol. 29, No. 3, 465-79 (July, 1957).

Neutrino physics is extended beyond the familiar study of emission and absorption processes, by theoretical analysis of the interaction of neutrinos with gravitational fields. Topics considered include: (1) Comparison of the binding of electrons in electrostatic and gravitational fields with the near-binding of neutrinos and photons in a gravitational field. (2) Thermal equilibrium of neutrinos. (3) Creation, destruction and scattering of neutrino pairs. (4) Interaction between pencils of neutrinos. (5) Neutrino geons. J.C.Taylor

539.12

1826. VANISHING OF THE NEUTRINO REST MASS. K.Nishijima.
Phys. Rev., Vol. 108, No. 3, 907-8 (Nov. 1, 1957).

The requirement that the mass of the neutrino be exactly zero may be satisfied by demanding invariance under many transformations besides the one proposed by Salam (Abstr. 9527/1957). One such, which involves a transformation on the muon (electron) field as well, leads to the selection rule: neutrinoless transitions involving an odd number of muons and an odd number of electrons are strictly forbidden. No such process has been observed. The theory of beta-decay is unaffected but, in muon decay, the predominant mode must be $\mu^+ \rightarrow e^+ + \nu_R + \nu_L$ in order to obtain the observed spectrum, so that the theory must include two kinds of two-component neutrinos. If leptons are conserved, there will be two kinds of "lepton charge", one carried by the muons and one group of neutrinos and the other by the electrons and the other type of neutrinos, and each will be conserved separately. P.K.Kabir

539.12

1827. SEARCH FOR ANTINEUTRINO INTERACTION WITH DEUTERONS. C.L.Cowan, Jr and F.Reines.
Phys. Rev., Vol. 107, No. 6, 1609-11 (Sept. 15, 1957).

The antineutrino-induced disintegration of the deuteron was sought using the antineutrino flux from a production reactor and a liquid scintillation detector, with a negative result. An upper limit of 4×10^{-45} cm^2 was placed on the interaction cross-section as compared with present predictions of 2×10^{-45} cm^2 for this cross-section. Suggestions are given for improving this experimental limit. A.

539.12 : 537.591.15

A HIGH-ENERGY ELECTRON–PHOTON SHOWER.
See Abstr. 1758

539.12

1828. ON THE QUASICLASSICAL INTERPRETATION OF QUANTUM EFFECTS IN THE THEORY OF A "LIGHT-EMITTING" ELECTRON. A.A.Sokolov and I.M.Ternov.
Dokl. Akad. Nauk SSSR, Vol. 117, No. 6, 967-70 (1957). In Russian.

The motion and radiation of an extreme relativistic electron in a given magnetic field are treated at length, with application, for example, to the case of the synchrotron radiation. First the appropriate classical equations are considered and solved (in the linear approximation). Then the quantized feature of the radiation is introduced by means of a "fluctuation force". The amplitudes of the radial and axial oscillations are calculated and an equation is deduced for the synchrotron oscillations. It was found that for the phase oscillations the result is the same as in the classical theory. P.Roman

539.12

1829. RELATIVISTIC ELECTRON–PROTON SCATTERING ACCORDING TO MESON THEORY. L.K.Pandit.
Nuovo Cimento, Vol. 7, No. 2, 263-5 (Jan. 16, 1958).

The results of a perturbation calculation of the spatial charge distribution of the proton, based on symmetric pseudoscalar meson theory with both direct and derivative couplings, are presented and the dependence on the cut-off Λ is considered. For $\Lambda \cong \frac{3}{2}M$, the results agree with experiment, with coupling content $G^2/4\pi = 31$. The question of the anomalous magnetic moment is discussed. G.H.Burkhardt

539.12

1830. POLARIZATION IN DOUBLE SCATTERING OF ELECTRONS. Yu.V.Anishchenko and A.A.Rukhadze.
Zh. éksper. teor. Fiz., Vol. 33, No. 1(7), 279-80 (1957). In Russian.

It is shown that in the Born approximation the azimuthal asymmetry in double scattering of a longitudinally polarized beam substantially exceeds the asymmetry in the double scattering of an unpolarized beam. G.E.Brown

539.12

1831. ON IMPROVEMENT OF PERTURBATION THEORY FORMULAE. R.V.Tevikyan.
Zh. éksper. teor. Fiz., Vol. 33, No. 2(8), 478-80 (1957). In Russian.

The n-fold Compton effect and scattering of electrons and positrons on electrons at high energies are studied by taking into account vacuum polarization diagrams composed of simple closed loops. A.

539.12

1832. ON THE SCATTERING OF ELECTRONS BY PROTONS. A.I.Akhiezer, L.N.Rozentsveĭg and I.M.Shmushkevich.
Zh. éksper. teor. Fiz., Vol. 33, No. 3(9), 765-72 (1957). In Russian.

It is shown that under some very general assumptions, scattering of electrons by protons is determined by two real functions $a(q^2)$ and $b(q^2)$ of the invariant $q^2 = (p_1 - p_2)^2$, where p_1 and p_2 are four-dimensional electron momenta before and after the collision. Experiments with polarized electrons and protons are considered which permit one in principle to determine the particular form of the functions $a(q^2)$ and $b(q^2)$. A.

539.12

1833. CHARACTERISTIC ENERGY LOSS OF ELECTRONS PASSING THROUGH METAL FOILS. II. DISPERSION RELATION AND SHORT WAVELENGTH CUTOFF FOR PLASMA OSCILLATIONS. R.A.Ferrell.
Phys. Rev., Vol. 107, No. 2, 450-62 (July 15, 1957).

Previous work (Abstr. 1290/1956) is extended so as to provide a determination of the shortest wavelength at which plasma oscillations can be sustained by a degenerate electron gas. The collective oscillations are treated without introducing collective coordinates, thereby avoiding possible complications associated with subsidiary conditions. Instead the Hartree self-consistent field method is used to provide a direct quantum-mechanical analogue to the Bohm–Gross derivation of the dispersion relation. The effect of electron exchange, calculated by replacing the Hartree by the Hartree–Fock method, somewhat decreases the dependence of the plasma frequency on wave-number. The maximum wave-number corresponds to the momentum just sufficient to cause an electron at the surface of the Fermi sea to make a real transition, absorbing one plasma quantum of energy. This criterion agrees well with Watanabe's measurement of the maximum angle by which electrons undergoing the characteristic energy loss are scattered. The previous work on the intensity of the characteristic energy loss as a function of angle is supplemented by a study near cutoff, where it is shown that the intensity drops rapidly to zero as the maximum angle of scattering is approached. By use of the generalized sum rule of Nozières and Pines it is also possible to study the contribution of one-electron excitation to the differential stopping power. Varying as the fourth power of the angle of scattering, this contribution is negligible at small angles and first becomes dominant as the cutoff is approached. A.

539.12

1834. ABSORPTION OF BETA PARTICLES IN LIQUIDS. S.A.Husain and A.K.Hilmi.
Proc. Phys. Soc. A, Vol. 70, Pt 12, 902-4 (Dec., 1957).

The absorption of P^{32} β-rays in various organic liquids is shown to follow the same curve when plotted in terms of $(Z^{4/3}/A) \times$ thickness in mg/cm^2. M.A.Grace

539.12

1835. SCATTERING OF HIGH-ENERGY POSITRONS AND ELECTRONS, AND LARGE ANGLE PAIR PRODUCTION, IN LEAD. R.C.Miller and C.S.Robinson.
Ann. Phys. (New York), Vol. 2, No. 2, 129-56 (Aug., 1957).

The absolute positron and electron fluxes from Pb targets irradiated by bremsstrahlung were observed at angles between 21° and 74° and energies between 50 and 170 MeV. The fluxes from aluminium were observed at 29.2°, and shown to agree closely with theory when the (rather small) effects of finite nuclear size are accounted for. The positron to electron ratios of aluminium suggest a direction for improvements on the first Born approximation calculation of large angle pair-production. By use of several target thicknesses the fluxes from Pb were separated into (1) large angle pair-production and (2) scattering of pair particles originally produced at 0°. The observed scattering of positrons and electrons is believed to be largely elastic, and on this assumption absolute scattering cross-sections were obtained. The pair flux and scattering cross-sections vary much less rapidly with energy and angle for positrons than for electrons. The squared form factor for positron scattering also varies less rapidly than for electron scattering, indicating less nuclear screening for positrons than for electrons. A similar conclusion is reached for pair production. The Pb +/− ratios, when extended to low energy, are consistent with theoretical results. A.

539.12

1836. THEORY OF PRODUCTION OF ELECTRON–POSITRON PAIRS IN COLLISIONS OF SLOW μ^- -MESONS WITH NUCLEI. L.M.Afrikyan.
Zh. éksper. teor, Fiz., Vol. 33, No. 1(7), 280 1 (1957). In Russian.

Results are given for the threshold region. G.E.Brown

539.12

1837. STATIONARY STATES OF AN ELECTRON–POSITRON SYSTEM AND ANNIHILATION TRANSITIONS. Chzhan Li.
Zh. éksper. teor. Fiz., Vol. 33, No. 2(8), 365-78 (1957). In Russian.

A scheme is proposed which permits one to take into account the effect of the external field and interaction between electrons and positrons when an electron–positron field interacts with a radiation field. If the photon energy is comparable with the electron rest-energy the theory is nonrelativistic with respect to particle momentum. If the photon energy is much smaller than the electron rest-energy some relativistic corrections may be applied by taking into consideration higher approximations. The proposed scheme is applied to the stationary states of an electron–positron system and to two-photon positron annihilation in a many-electron system. Fock's self-consistent field equations have been obtained for an electron–positron system. The probability of positron annihilation in a many-electron system is also derived. The particular case of annihilation in helium is considered. A.

539.12 : 539.2

1838. ANGULAR CORRELATION OF ANNIHILATION RADIATION IN VARIOUS SUBSTANCES. G.Lang and S.DeBenedetti.
Phys. Rev., Vol. 108, No. 4, 914-21 (Nov. 15, 1957).

The angular correlations of gamma-ray pairs arising from positron annihilation in various solids were observed. With good resolution, measurements of these angular distributions were made for a wide variety of metallic elements, several ionic salts, several insulators, and a semiconductor. Some of the results from metals are accountable in terms of the Fermi-gas model of conduction electrons and the assumption of thermalized positrons. Many metals exhibit angular distributions which differ significantly from the Fermi-gas type, while retaining some of its features. For the noble and transition metals, however, the simple treatment is completely inadequate. Some possible theoretical interpretations of these distributions are indicated. Measurements made on a group of alkali halides indicate the dominance of the halogen in determining the angular distribution, the width of which increases regularly with the chemical activity. The possibility of using positrons to study Pd–H alloys was investigated. A measurement of positron mobility in diamond yielded a null result, within the accuracy of the experiment. A.

539.12

1839. ON THE PROBLEM OF BOUND STATES IN POSITRONIUM. Yu.A.Tarasov.
Zh. éksper. teor. Fiz., Vol. 33, No. 3(9), 706-9 (1957). In Russian.

It is shown that the bound states of an electron and a positron can be studied by investigating the poles of the photon propagation function. A.

539.12

1840. TWO-NUCLEON POTENTIAL FROM A MODEL OF PION–NUCLEON INTERACTION. F.Ferrari and L.Fonda.
Nuovo Cimento, Vol. 6, No. 6, 1510-12 (Dec., 1957).

An intermediate boson field is introduced for the interaction between a nucleon and a pion (Abstr. 5417/1956). With this assumption, the authors derive a two-nucleon potential, which, with further assumptions, reproduces in part the Gartenhaus potential (Abstr. 921/1956). To obtain the appropriate cut-off, the mass of the intermediate meson is taken to be five times the mass of the pion. J.Lascoux

539.12

1841. ON THE STRUCTURE OF THE NUCLEON CORE. G.Domokos.
Nuovo Cimento, Vol. 6, No. 6, 1513-15 (Dec., 1957).

An estimation of the K-meson contribution to the electromagnetic structure of the nucleon "seems to indicate that both the magnetic moment and neutron–electron interaction can be put in order" if the K-meson–baryon coupling constant is of the same order as the pion–nucleon coupling constant. P.K.Kabir

539.12

1842. PROBLEM OF THE STRUCTURE OF THE NUCLEON. B.S.Neganov.
Zh. éksper. teor. Fiz., Vol. 33, No. 1(7), 260-2 (1957). In Russian.

The nucleon is viewed as a composite system of a Ξ-hyperon and two K-mesons. Dissociation of the nucleon can proceed by one of these particles absorbing a π-meson. If one of the K-mesons absorbs it, the emitted K's will be strongly peaked forwards. G.E.Brown

539.12

1843. NUCLEON–ANTINUCLEON INTERACTION AT INTERMEDIATE ENERGIES. J.S.Ball and G.F.Chew.
Phys. Rev., Vol. 109, No. 4, 1385-91 (Feb. 15, 1958).

The Yukawa interaction between nucleon and antinucleon is investigated in the intermediate energy range (50 to 200 MeV) where it is shown that the details of the short-range forces are unimportant; that is, cross-sections are primarily determined by the pion exchange potential for distances greater than 10^{-13} cm. Numerical calculations by the W.K.B. method, using two possible forms of the potential, give nucleon–antinucleon cross-sections several times larger than the nucleon–nucleon cross-sections at

corresponding energies. This large difference is due to systematic cancellation effects in the nucleon–nucleon interaction which are removed in the nucleon–antinucleon system. It is shown that irregularities in the annihilation cross-section as a function of energy are to be expected as a result of the sudden onset of individual partial waves. A.

539.12 : 530.145

1844. DISPERSION RELATIONS FOR NUCLEON–NUCLEON SCATTERING.
M.L.Goldberger, Y.Nambu and R.Oehme.
Ann. Phys. (New York), Vol. 2, No. 3, 226-82 (Sept., 1957).

Dispersion relations are presented. The general case of non-forward scattering is treated, although the majority of the discussion is confined to the limiting cases of forward scattering and the non-relativistic approximation. It is shown that in the relativistic case the dispersion relations for nucleon–nucleon scattering necessarily involve the nucleon–antinucleon amplitude. Some qualitative conclusions are drawn about the differences between the nucleon–nucleon and nucleon–antinucleon interactions. The concept of a potential in quantum field theory is discussed briefly. A.

539.12

1845. THE SCATTERING OF NUCLEONS BY ALPHA-PARTICLES. P.E.Hodgson.
Advances in Phys., Vol. 7, 1-39 (Jan., 1958).

A review of experimental and theoretical work at all energies. The article includes work on polarization effects and meson production, and an extensive bibliography (4 pages). S.J.Goldsack

539.12 : 530.145

NUCLEON–NUCLEON SCATTERING AT HIGH ENERGY. See Abstr. 1515

539.12 : 530.145

DIFFERENTIAL AND TOTAL CROSS SECTIONS FOR NUCLEON-ANTINUCLEON SCATTERING. See Abstr. 1517

539.12 : 539.17

PROTONS FROM $Fe^{54}(n,p)$ AND $Fe^{56}(n,p)$ REACTIONS. See Abstr. 1267

539.12

1846. POLARIZATION IN PROTON–PROTON SCATTERING AT 3 AND 4 MeV. M.H.Hull, Jr and J.Shapiro.
Phys. Rev., Vol. 109, No. 3, 846-50 (Feb. 1, 1958).

A phase-shift analysis of the proton–proton scattering data of Worthington, McGruer, and Findley is carried out in an attempt to find fits which also lead to polarization of non-negligible size. Such fits, having P wave phase-shifts separated in spin–orbit order with first Born approximation spin–orbit splittings, have been found, giving a polarization as large as 4%. Phase shifts for $L \leq 2$ are included, with those for higher values of L, J put equal to zero. A.

539.12

1847. VACUUM POLARIZATION EFFECTS IN PROTON–PROTON SCATTERING. L.Durand, III.
Phys. Rev., Vol. 108, No. 6, 1597-611 (Dec. 15, 1957).

The problem of vacuum polarization scattering of protons by protons is treated to first order in the vacuum polarization interaction. The phase shifts caused by the interaction are calculated, and the corresponding addition to the p–p scattering matrix is constructed. The phase shifts are calculated using Coulomb wave-functions as the unperturbed wave-functions. The corresponding addition to the p–p scattering matrix is then constructed, including exactly the Coulomb phase-shift factors $\exp[2i(\sigma_L-\sigma_0)]$ appearing in the series representation of the scattering amplitudes. Other electromagnetic and relativistic modifications of the Coulomb scattering amplitudes are also examined in the limit of low energies. Numerical results are given for the vacuum polarization contributions to the p–p scattering cross-section over the energy range 1.4-4.2 MeV. It is found that vacuum polarization scattering may easily be confused with nuclear P-wave scattering. A.

539.12

1848. NEUTRON–PROTON SCATTERING IN THE ENERGY RANGE 70 TO 170 MeV.
T.C.Griffith, A.P.Banford, M.Y.Uppal and W.S.C.Williams.
Proc. Phys. Soc., Vol. 71, Pt 3, 305-24 (March, 1958).

The angular distributions of neutrons scattered by protons at effective energies of 96, 130 and 137 MeV and at angles between 19.3^0 and 78.1^0 in the centre-of-mass system have been measured using photographic emulsions. The differential cross-sections have been normalized to the absolute scale by deducing the energy spectrum of the neutrons. The results confirm that at 130 and 137 MeV the cross-sections for scattering at angles within 60^0 of the forward direction in the centre-of-mass system are less than those for a similar range of angles in the backward direction. A.

539.12

1849. SMALL-ANGLE SCATTERING OF FAST NEUTRONS BY HEAVY NUCLEI. Yu.A.Aleksandrov.
Zh. éksper. teor. Fiz., Vol. 33, No. 1(7), 294-6 (1957). In Russian.

Differential cross-sections are measured for neutrons of energy 680-890 keV. An anomalous rise at small angles ($< 11^0$) is observed for Pu and U, which might be attributed to the polarizability of the neutron. G.E.Brown

539.12 : 539.19

1850. SCATTERING OF SLOW NEUTRONS BY DIATOMIC MOLECULES. A.A.Ansel'm.
Zh. éksper. teor. Fiz., Vol. 33, No. 3(9), 625-33 (1957). In Russian.

The cross-sections for elastic and inelastic scattering of neutrons by molecules composed of two identical or different atoms are computed. The general formulae thus obtained are used to study scattering on T_2, HT and DT molecules. Comparison of the scattering cross-sections in these gases with the obtained theoretical formulae permits one to determine the scattering amplitude for neutrons on a tritium nucleus. A.

539.12

1851. THE DIFFUSION COEFFICIENT OF THERMAL NEUTRONS.
I.Kuščer and M.Ribarič.
Nuovo Cimento, Vol. 7, No. 4, 451-60 (Feb. 16, 1958).

Diffusion of slow neutrons in an extended uniform medium is treated by a method which accounts for the thermal motion of the medium. If neutron capture is absent, a single integral equation has to be solved, in order to determine the velocity distribution and the diffusion coefficient. A system of such equations is obtained for a capturing medium. For the case of a non-capturing monoatomic gaseous medium several approximations are discussed, which express the diffusion coefficient as a function of the atomic weight. A.

539.12

1852. NEUTRON TIME-OF-FLIGHT SPECTROMETER FOR USE WITH THE HARWELL 110 INCH CYCLOTRON.
J.P.Scanlon, G.H.Stafford, J.J.Thresher and P.H.Bowen.
Rev. sci. Instrum., Vol. 28, No. 10, 749-57 (Oct., 1957).

A description is given of a neutron time-of-flight spectrometer used for energies up to 140 MeV. A 20 mμsec neutron pulse is obtained by electrostatic deflection of the internal proton beam of the cyclotron onto a thick aluminium target. By timing the neutrons over a 26 metre flight path an energy spread of 4.2% at 15 MeV is obtained rising to 14% at 140 MeV. The advantages of the technique and possible improvements are discussed. A.

539.12

1853. GAS-RECOIL FAST NEUTRON SPECTROMETER.
R.E.Benenson and M.B.Shurman.
Rev. sci. Instrum., Vol. 29, No. 1, 1-9 (Jan., 1958).

A gas-recoil fast neutron spectrometer based on the collimation scheme of Giles (Abstr. 2770/1954) was constructed and its behaviour analysed. The principal effort was directed to improving peak-to-valley ratio of the instrument. Electron capture was minimized and anticoincidence end-effect counters included. A graphical analysis is made of the collimation scheme and the results predicted by the analysis compared with experiment. $Li^7(p,n)Be^7$ and $D(d,n)He^3$ neutron groups were observed using, in turn, palladium-filtered hydrogen and pure propane as spectrometer fillings. Energy spreads of 10% and under with efficiencies exceeding 10^{-4} were obtained with peak-to-valley ratios of 10 to 1. Neutron groups from the $Be^9(d,n)B^{10}$, $C^{12}(d,n)N^{13}$, $O^{16}(d,n)F^{17}$, and $A^{40}(d,n)K^{41}$ reactions were observed. A.

539.12

1854. K-MESONS AND HYPERONS. THEIR STRONG AND WEAK INTERACTIONS. R.H.Dalitz.
Rep. Progr. Phys., Vol. 20, 163-303 (1957).

A survey of the data available at the close of 1956 on production and decay processes and nuclear interactions of K-mesons and hyperons. The phenomena are interpreted within the framework of the charge-independent classification scheme proposed by Gell-Mann and by Nishijima in terms of a law of conservation of "strangeness" after the assignment of a strangeness quantum number to each strongly interacting particle. Decay processes are discussed in detail with special reference to their violation of the strangeness conservation law and the success of Gell-Mann's $\Delta T = 1/2$ rule in

the cases which involve changes in the total isotopic spin. The data on the decay of neutral K's is reviewed, including the search for a long-lived K^0. The spin, parity and decay modes of τ and θ are considered and a nine-page appendix (added May 1957) discusses the significance of the failure of parity conservation and of charge-conjugation invariance in certain weak decay processes. The observations of bound Λ^0 hypernuclei are related to the Λ^0–nucleon interaction and the Λ^0 spin and parity. A section is devoted to anomalous events and their importance in attempts to construct a theoretical foundation leading naturally to the Gell-Mann–Nishijima scheme. Six pages of references are provided. E.J.Burge

539.12

1855. ON POSSIBLE REGULARITIES UNDERLYING THE SCHEME OF ELEMENTARY PARTICLE STATES. N.Dallaporta.
Nuovo Cimento, Vol. 7, No. 2, 200-14 (Jan. 16, 1958).

A scheme is presented in which all baryons are considered to be fundamentally the same, being represented by spinors both in ordinary and in isotopic spaces, and the transitions between various baryon states are effected by three different operators, each of which may be formally represented by Pauli spin matrices, associated with the emission or absorption of charged pions, neutral K-mesons, and of charged K-mesons respectively. The introduction of the third operator (and the corresponding internal degree of freedom for the baryon) is necessary to avoid contradiction with the Gell-Mann–Nishijima rules. It is shown that interaction with the meson fields can mix two of the baryon doublets and give rise to the singlet Λ^0 and triplet $\Sigma^{+,0,-}$ states as observed.

P.K.Kabir

539.12 : 530.145

WEAK LEPTON PROCESSES. See Abstr. 1499

539.12

1856. AN EXPERIMENTAL TEST OF THE FERMI–TELLER "Z-LAW".
J.C.Sens, R.A.Swanson, V.L.Telegdi and D.D.Yovanovitch.
Nuovo Cimento, Vol. 7, No. 4, 536-44 (Feb. 16, 1958).

Fermi and Teller predicted, in their classic paper on the slowing-down process of negative mesons, the relative probabilities with which the latter should be captured by the different atoms of a chemical compound. They concluded that these atomic capture probabilities should be proportional to the nuclear charges, Z_i, of the atoms considered. The experiments here described were carried out to check this prediction. They are based on the fact that negative muons reach rapidly the K-orbits around the nuclei of the atoms of the material in which they are slowed down, and disappear from these orbits (either by decay or absorption) at rates which are characteristic for the nuclei in question. Thus the time distribution of decay electrons emerging from a chemical compound in which muons are brought to rest presents in general as many exponential components as there are constituents; their intercepts at time zero (entry of the muons into the material) are directly proportional to $n_i p_i$, where n_i = fraction of component of atomic number Z_i, p_i = capture probability into the mesic K-shell of atom of same constituent. Neglecting the possibility of transfer of muons between neighbouring atoms, these p_i are equivalent to the capture probabilities predicted by Fermi and Teller. The present experiments show at least in insulators (Al_2O_3, P_2O_5, SiO_2, CCl_4, KOH, KHF_2, p-dichlorobenzene) the predictions of Fermi and Teller do not hold. No weighing of n_i with Z_i seems to arise, the lighter element being even preferred in some cases. As an explanation, it is pointed out that the energy loss to lattice vibrations, not considered by Fermi and Teller, may be an important mechanism in insulators for negative particles of nearly zero kinetic energy, i.e. at the point of being captured. A.

539.12

1857. TRANSITION AMPLITUDES FOR PHOTOPRODUCTION OF MESONS FROM NUCLEONS AND PHOTODISINTEGRATION OF THE DEUTERON. L.D.Pearlstein and A.Klein.
Phys. Rev., Vol. 107, No. 3, 836-42 (Aug. 1, 1957).

An elementary technique of general applicability is applied to the explicit construction as operators in the spin space of the particles involved, of the transition matrices for photoproduction of mesons from nucleons and photodisintegration of the deuteron.

A.

539.12

1858. TIME REVERSAL EFFECTS IN MUON DECAY.
R.T.Sharp and G.Bach.
Canad. J. Phys., Vol. 35, No. 10, 1199-203 (Oct., 1957).

Expressions are given for the distribution of electrons emitted in the decay of aligned muons as a function of their energy, direction, and spin. The two-component neutrino theory of Yang and Lee is used, and two cases are considered: (i) neutrino and antineutrino emitted; (ii) two neutrinos emitted. Various correlation terms arise as a result of the inclusion of electron spin. Among these is a time reversal dependent term whose presence would be evinced by asymmetry in a transverse polarization of electrons emitted at right angles to the muon spin. A.

539.12

1859. MU DECAY WITH NONCONSERVATION OF PARITY.
S.Larsen, E.Lubkin and M.Tausner.
Phys. Rev., Vol. 107, No. 3, 856-8 (Aug. 1, 1957).

The distribution of the decay electrons from polarized μ-mesons is calculated, without presumption of parity conservation, time-reversal invariance, or charge-conjugation invariance. The four-component neutrino theory is used. The result is expressed in terms of three parameters, ρ, α, and ξ, of which ρ is the usual Michel parameter. Theoretical inequalities among these parameters are given. An analysis of experimental data is made in terms of these parameters, and the results are found to be in fair agreement with the more stringent requirements of two-component neutrino theory.

A.

539.12

1860. POSSIBLE NONLOCAL EFFECTS IN μ DECAY.
T.D.Lee and C.N.Yang.
Phys. Rev., Vol. 108, No. 6, 1611-14 (Dec. 15, 1957).

Possible nonlocal effects in μ-decay are investigated phenomenologically. It is shown that the possible difference between the experimental ρ value from $\frac{3}{4}$ can be attributed to such nonlocal phenomena. A.

539.12

1861. MOMENTUM SPECTRUM OF POSITRONS FROM THE DECAY OF μ^+ MESONS. L.Rosenson.
Phys. Rev., Vol. 109, No. 3, 958-72 (Feb. 1, 1958).

The momentum spectrum of positrons from μ^+ decay was examined. The detecting instrument was a 20 atm hydrogen-filled diffusion cloud-chamber, operated in a magnetic field of 7000 gauss. The data are compared with the spin-$\frac{1}{2}$ μ-meson theory of Michel, as modified by Behrends, Finkelstein, and Sirlin, to include first radiative corrections, and with the spin $\frac{3}{2}$ theory of Behrends and Fronsdal. Statistical analysis of the 1300 acceptable events yields the shape parameters $\rho_R = 0.65 \pm 0.05$ (standard deviation) and $\rho_{3/2} = 0.26 \pm 0.04$ (standard deviation). The theoretical spectra described by shape parameters in the vicinity of the best fits are very similar and this experiment cannot discriminate between the two spin assignments for the μ meson. The value of ρ_R can be related to the Michel parameter ρ_M, and gives $\rho_M = 0.67 \pm 0.05$ (standard deviation. The result for ρ_{Michel} was related to published β-decay data, and restrictions on a common interaction for β and μ decay were deduced. A.

539.12 : 530.145

μ-MESON DECAY IN THE THEORY OF INDIVIDUAL MASS REVERSAL AND IN THE TWO COMPONENT THEORY OF NEUTRINO. See Abstr. 1498

539.12

1862. MAGNETIC MOMENT OF THE FREE MUON.
T.Coffin, R.L.Garwin, S.Penman, L.M.Lederman and A.M.Sachs.
Phys. Rev., Vol. 109, No. 3, 973-9 (Feb. 1, 1958).

The magnetic moment of the positive μ-meson was measured in several target materials by a magnetic resonance technique. Muons were brought to rest with their spins parallel to a magnetic field. A radiofrequency pulse was applied to effect a spin reorientation which was detected by counting the decay electrons emerging after the pulse in a fixed direction. Results are expressed in terms of a g factor which for a spin $\frac{1}{2}$ particle is the ratio of the actual moment to $e\hbar/2m_\mu c$. The most accurate result obtained in a $CHBr_3$ target, is that $g = 2(1.0026 \pm 0.0009)$ compared to the theoretical prediction of $g = 2(1.0012)$. Less accurate measurements yielded $g = 2.005 \pm 0.005$ in a copper target and $g = 2.00 \pm 0.01$ in a lead target. A.

539.12

1863. KINEMATIC DEPOLARIZATION OF μ-MESONS EMITTED IN π-MESON DECAYS. J.Werle.
Nuovo Cimento, Vol. 7, No. 2, 255-8 (Jan. 16, 1958).

In the $\pi-\mu-e$ decay chain, some pions decay in flight, and so the longitudinal polarization of the muons is not complete. Analysis shows that this effect may have led to some confusion in the interpretation of experiment. J.C.Taylor

539.12

1864. SPACE PROPERTIES OF THE π MESON.
R.L.Garwin, G.Gidal, L.M.Lederman and M.Weinrich.
Phys. Rev., Vol. 108, No. 6, 1589-93 (Dec. 15, 1957).

Measurements were made of the circular polarization of the decay photons emitted from an "unpolarized" sample of π^0 mesons, the asymmetric emission of μ^+ mesons from cyclotron-produced π^+ mesons, and the asymmetric emission of μ^+ mesons from π^+ mesons produced in weak interactions. All three experiments give negative results. A.

539.12

1865. RADIATIVE BETA DECAY OF THE PION. J.C.Taylor.
Nuovo Cimento, Vol. 6, No. 5, 1226-7 (Nov., 1957).

If nuclear beta decay has a tensor term, the radiative beta decay of the pion should have been seen. This difficulty is resolved if the pion–nucleon interaction is assumed to be pseudo-vector, not pseudo-scalar. J.C.Taylor

539.12

1866. PION–ELECTRON DECAY. M.Kawaguchi and K.Nishijima.
Phys. Rev., Vol. 108, No. 3, 905-7 (Nov. 1, 1957).

On the basis of special invariance assumptions for the interactions, a partial cancellation is expected between nucleon and Ξ-particle intermediate states in the decay $\pi^+ \rightarrow e^+ + \nu + \gamma$ which reduces the rate expected for this process from the nuclear β-decay interaction. The disagreement with experiment for T interaction is thereby reduced. G.H.Burkhardt

539.12

1867. ANGULAR DISTRIBUTION IN NEUTRAL MESON DECAY.
J.E.Leiss and R.A.Schrack.
Phys. Rev., Vol. 109, No. 4, 1326-8 (Feb. 15, 1958).

A search was made for an asymmetry in the decay photons from photoproduced neutral pions around the direction of motion of the pions. No asymmetry was found. This indicates that if the pions should have nonzero spin, they are not polarized or aligned in the photoproduction process. A.

539.12

1868. ENERGY SPECTRUM OF γ-QUANTA FROM THE DECAY OF π^0-MESONS PRODUCED BY 660 MeV PROTONS ON HYDROGEN NUCLEI. Yu.D.Bayukov and A.A.Tyapkin.
Zh. éksper. teor. Fiz., Vol. 32, No. 5, 953-6 (1957). In Russian.

The energy spectrum of these γ-quanta was measured. The angular and energy distribution of π^0-mesons produced in p–p collisions was obtained by analysing the γ-quantum spectrum. A.

539.12

1869. ENERGY DEPENDENCE OF THE ANGULAR CORRELATION IN $\pi^+ - \mu^+ - e^+$ DECAY. A.O.Vaĭsenberg and V.A.Smirnitskiĭ.
Zh. éksper. teor. Fiz., Vol. 33, No. 3(9), 621-4 (1957). In Russian.

The energy spectrum of $\pi^+ - \mu^+ - e^+$ positrons in photoemulsion and the energy dependence of the angular correlation in the $\pi^+ - \mu^+ - e^+$ decay have been studied. Coefficient A in the angular correlation formula $1 + A \cos\theta$ is shown to increase with positron energy in accordance with the theory of two-component neutrino. A.

539.12

1870. SEARCH FOR ASYMMETRIES IN THE SCATTERING AND DECAY OF PIONS.
A.V.Crewe, U.E.Kruse, R.H.Miller and L.G.Pondrom.
Phys. Rev., Vol. 108, No. 6, 1531-3 (Dec. 15, 1957).

The possibility of nonzero spin for the π meson has recently been reconsidered. This might manifest itself in asymmetries in scattering of pions or anisotropies of $\pi - \mu$ decays. In this experiment, asymmetries in the scattering of pions from carbon and in the decay of pions in flight were sought by using counter techniques. No left-right or up-down scattering asymmetry was observed within a combined statistical and systematic precision of 6-7%. No decay asymmetry was observed within a combined statistical and systematic precision of 5%.

539.12

1871. ELASTIC SCATTERING OF 307 MeV π^--MESONS ON HYDROGEN. V.G.Zinov and S.M.Korenchenko.
Zh. éksper. teor. Fiz., Vol. 33, No. 2(8), 335-8 (1957). In Russian.

The angular distribution of π^--mesons elastically scattered on hydrogen was studied with scintillation counters. The energy of the incident π^--mesons was 307 ± 9 MeV. The π^--meson angular distribution obtained in the centre-of-mass system can be satisfactorily described by the expression $d\sigma/d\omega = (0.56 + 0.42 \cos\theta + 1.1 \cos^2\theta) \times 10^{-27}$ cm^2.sterad^{-1}. Results of phase-shift analysis carried out on the assumption that only S- and P-waves contribute to scattering are presented. From comparison of the obtained data with the dispersion relations it is concluded that the meson–nucleon coupling constant f^2 is of the order of 0.08. A.

539.12

1872. ON THE THRESHOLD BEHAVIOR OF THE NEGATIVE TO POSITIVE RATIO IN PION PHOTOPRODUCTION. M.J.Moravcsik.
Nuovo Cimento, Vol. 7, No. 4, 442-50 (Feb. 16, 1958).

It is shown that the extrapolation used by Beneventano et al. to obtain the negative to positive ratio at threshold is very sensitive to small alterations which can be made due to the approximate nature of the procedure. Such small alterations bring about very substantial changes in the energy dependence of the ratio near threshold and hence the extrapolation is quite ambiguous in the absence of extensive experimental data on the ratio in this energy region. Since such extensive set of data does not exist at the present time, it is concluded that there is no good reason to believe that the ratio at threshold is in disagreement with the theoretical predictions. A.

539.12

1873. THE ELASTIC PHOTOPRODUCTION OF NEUTRAL PIONS FROM HELIUM. E.H.Bellamy, R.W.P.McWhirter and P.Palit.
Proc. Phys. Soc. A, Vol. 70, Pt 10, 763-5 (Oct., 1957).

The cross-section for the reaction $\gamma + He^4 \rightarrow \pi^0 + He^4$ was measured for photon energies between 260 and 310 MeV, at two angles. J.M.Cassels

539.12

1874. CREATION OF π^+-MESONS IN p–p COLLISIONS IN THE 480–660 MeV RANGE. B.S.Neganov and O.V.Savchenko.
Zh. éksper. teor. Fiz., Vol. 32, No. 6, 1265-75 (1957). In Russian.

The energy spectra of π^+-mesons produced in $p + p \rightarrow \pi^+ + n + p$ and $p + p \rightarrow \pi^+ + d$ reactions were measured at four angles in the laboratory system by employing a 660 MeV proton beam. The differential cross-section for π^+-meson production has been measured at eight angles in the same system. The total cross-section for the first reaction is (10.9 ± 1.1) millibarns and the angular distribution is proportional to $(0.66 \pm 0.14) + \cos^2\theta$. The excitation function for this reaction in the 480–660 MeV range can be approximated by a power function of the form 0.67 $P_{max}^{4.7}$ millibarns, where P_{max} is the maximal meson momentum in the c.m.s. expressed in $m_{\pi^+}c$ units. A.

539.12

1875. DIFFERENTIAL CROSS-SECTION FOR PHOTOPRODUCTION OF π-MESONS ON NUCLEONS TAKING d-STATES INTO ACCOUNT. N.F.Nelipa.
Zh. éksper. teor. Fiz., Vol. 33, No. 1(7), 271-3 (1957). In Russian.

A general expression for the cross-section in terms of the amplitudes for the various transitions is given. G.E.Brown

539.12 : 539.17

1876. PRODUCTION OF NEUTRAL π-MESONS ON NUCLEI OF VARIOUS ELEMENTS BY 260–660 MeV PROTONS.
Yu.D.Prokoshkin and A.A.Tyapkin.
Zh. éksper. teor. Fiz., Vol. 33, No. 2 (8), 313-19 (1957).

Angular distribution measurements were made of γ-ray yields resulting from the decay of π^0-mesons, produced on complex nuclei by 260-660 MeV protons. In this energy range the total cross-sections of π^0-meson production on various nuclei were determined. A.

539.12 : 539.17

1877. ON PRODUCTION OF π-MESONS BY PROTONS ON NUCLEI OF VARIOUS ELEMENTS. A.A.Ansel'm and V.M.Shekhter.
Zh. éksper. teor. Fiz., Vol. 33, No. 2(8), 481-4 (1957). In Russian.

Dependence of the probability of formation of π-mesons created in collisions between protons and nuclei on the number of nucleons in the nucleus A is considered. Deviation from the $A^{2/3}$ law is ascribed to effective attenuation of the proton beam penetrating the nucleus. A.

539.12 : 539.17

1878. PRODUCTION OF NEGATIVE π-MESONS BY 660 MeV PROTONS ON NUCLEI OF VARIOUS ELEMENTS.
A.G.Meshkovskiĭ, Ya.Ya.Shalamov and V.A.Shebanov.
Zh. éksper. teor. Fiz., Vol. 33, No. 3(9), 602-5 (1957). In Russian.

The energy spectra and cross-sections for production of π^--mesons have been measured at an angle of 45° with respect to the proton beam for Li, Be, Al and Cu. The differential cross-sections $d^2\sigma^-/d\Omega dE$ for 157 MeV π^--mesons have been measured for Ag and

Pb. A conclusion concerning the dependence of the cross-section for π -meson production on atomic weight has been drawn for elements lying between Li and Pb. A comparison with similar results for π^0-mesons and π^+-mesons reported by other workers is carried out. A.

539.12

1879. SOME REMARKS ON PARITY NON-CONSERVATION AND THE τ–Θ DILEMMA. S.Gotô.
Nuovo Cimento, Vol. 7, No. 3, 278-89 (Feb. 1, 1958).

Lee and Yang have succeeded in ascribing parity non-conservation in weak interactions to the singular nature of the mass zero neutrino — a screwon theory of two component neutrino. In this paper two kinds of neutrinos are introduced — the right circularly polarized neutrino and the left circularly polarized neutrino in the normal particle state — in order to forbid unwanted processes such as $\mu^{\pm} \rightarrow e^{\pm} + e^+ + e^-$ and $\mu^- + p \rightarrow p + e^-$ which are not forbidden in the Lee–Yang original formulation, and a possibility is discussed of solving the so-called τ–Θ dilemma by virtue of the virtual neutrino's effect. A.

539.12

1880. ANOMALOUS K^+ DECAY.
G.Harris, J.Lee, J.Orear and S.Taylor.
Phys. Rev., Vol. 108, No. 6, 1561-3 (Dec. 15, 1957).

Out of 5000 K^+ mesons, one was found with a π^+ secondary of 60 MeV which exceeds the 53 MeV upper limit for the alternate tau decay mode. In view of the estimate of Dalitz, it is reasonable that this be the first observed case of the possible decay mode: $K^+ \rightarrow \pi^+ + \pi^0 + \gamma$. There is strong evidence against the possibility that this event is a τ' decay in flight, and also against the possibility that the secondary might be a μ^+ rather than a π^+. A.

539.12

1881. ON THE K_{e3}-DECAY. L.B.Okun'.
Zh. éksper. teor. Fiz., Vol. 33, No. 2(8), 525-6 (1957). In Russian.

The energy distributions of electrons and π-mesons emitted in K_{e3}-decays are computed. Measurement of these distributions should permit one to establish the type of decay interaction, verify conservation of time parity and determine the strong interaction form-factors $g(E_\pi)$ in these decays. A.

539.12

1882. ON THE DECAY INTERACTIONS OF NEUTRAL K_{e3} AND $K_{\mu 3}$. S.Furuichi.
Nuovo Cimento, Vol. 7, No. 3, 269-77 (Feb. 1, 1958).

The decay interactions of the processes $K^0 \rightarrow e + \nu + \pi^C$ and $K^0 \rightarrow \mu + \nu + \pi^C$ are investigated. Under the assumption that these processes occur through weak Fermi interaction an analysis is made of the energy spectra and angular correlations of charged secondaries in order to obtain some information about the decay interactions. A.

539.12

1883. K^- MESON EXPOSURES IN WATER-SOAKED EMULSIONS.
G.Ascoli, R.D.Hill and T.S.Yoon.
Nuovo Cimento, Vol. 7, No. 4, 565-9 (Feb. 16, 1958).

A technique is described whereby pellicle strips of G5 emulsion are soaked in water and exposed as a stack of pellicles in intimate contact with one another. This technique allowed the normal process of tracing-through to be carried out and complete analysis of events was observed to be possible. The performance of the soaked emulsions, when they were exposed to a K^--meson beam, is described and compared with that of unsoaked G5 emulsions exposed in the same beam. A.

539.12

1884. THE STIMULATED DECAY OF THE LAMBDA HYPERON. I.
F.Ferrari and L.Fonda.
Nuovo Cimento, Vol. 7, No. 3, 320-7 (Feb. 1, 1958).

In order to interpret the experimental result (see following abstract) regarding the stimulated decay of Λ-hyperons bound in hyperfragments, a model is considered in which the decay of the Λ-hyperon may also occur when in the virtual Σ-state. The consequences of the non-conservation of parity are also considered. A.

539.12

1885. STIMULATED DECAY OF THE Λ HYPERON IN LIGHT HYPERFRAGMENTS. M.Baldo-Ceolin, C.Dilworth, W.F.Fry, W.D.B.Greening, H.Huzita, S.Limentani and A.E.Sichirollo.
Nuovo Cimento, Vol. 7, No. 3, 328-37 (Feb. 1, 1958).

From a group of double stars which were produced by 4.5 GeV negative pions, a selection was made of those events with linking tracks longer than 20 μm and which appeared to represent the non-mesonic decays, mainly, of ${}_\Lambda$He, ${}_\Lambda$Li, and ${}_\Lambda$Be hyperfragments. A total of 31 hyperfragments satisfied these criteria. From a study of the energy distribution of the charged particles from these disintegrations, is was found possible to separate the decays into those where the hyperon was stimulated into decaying by a neutron, from those caused by a proton. The ratio of neutron to proton stimulation is found to be about 1.4. This value may give some indications about the parity of the Λ hyperon and the possible transition $\Lambda \rightarrow \Sigma + \pi$. A.

539.12

1886. DECAY OF THE Σ^+ HYPERON AND ITS ANTIPARTICLE.
S.Okubo.
Phys. Rev., Vol. 109, No. 3, 984-5 (Feb. 1, 1958).

Two decay modes of the Σ^+ hyperon and the corresponding ones for its antiparticle are investigated. The branching ratio may be different for both, if charge-conjugation invariance or time-reversal invariance does not hold. A.

539.12 : 530.145

1887. ON THE PROBABILITY OF DECAY OF Σ-HYPERONS WITH NON-CONSERVATION OF PARITY.
I.Yu.Kobzarev and L.B.Okun'.
Zh. éksper. teor. Fiz., Vol. 33, No. 1(7), 296-7 (1957). In Russian.

It is shown that, if account is taken of parity non-conservation in Σ-decay, the experimental data of Alvarez do not necessarily contradict the selection rule $\Delta T = \frac{1}{2}$. P.K.Kabir

539.12 : 539.17

1888. PRODUCTION OF Λ^0 PARTICLES IN LEAD AND CARBON BY 2.5 BeV PROTONS.
E.R.Mosburg, Jr, E.C.Fowler and H.L.Kraybill.
Phys. Rev., Vol. 108, No. 3, 865-71 (Nov. 1, 1957).

In a systematic study of 18 000 pictures taken at the Cosmotron with the Yale diffusion cloud-chamber, two Λ^0 decays were found having origin in a lead plate at the upstream edge of the chamber. With corrections for the geometric efficiency of the chamber and for the scanning efficiency, this leads to an upper limit of approximately 8 mb per lead nucleus for the production of Λ^0 particles. Thirty-seven nuclear interactions, found in the methane gas of the chamber, indicate a cross-section of 155 ± 45 mb for star production in carbon. A two-dimensional Monte Carlo calculation of the internal pion–nucleon cascade in carbon was carried out for 45 events. Computed values for the π^+/π^- ratio and for the number of emerging charged pions per event are compared with those for the experimental carbon stars. It is concluded that the Monte Carlo calculation exaggerates the cascade and thus provides an upper limit to the multiplicity of cascade-induced events. A lower limit is provided by considering only the first collision of each Monte Carlo event. A count of the Monte Carlo fast internal pion collisions for which the production of a hyperon is energetically possible leads to an upper limit of 0.7 mb and a lower limit of 0.1 mb per carbon nucleus for Λ^0 production via the intermediate pion mechanism. Correction by Jastrow's lead-to-carbon production ratio yields Monte Carlo cross-sections for lead which indicate that this mechanism may dominate over production in direct collisions between the incoming proton and internal nucleons. A.

539.12

1889. ASSOCIATED PRODUCTION OF STRANGE PARTICLES BY 1.1 BeV π^-MESONS. J.L.Brown, D.A.Glaser and M.L.Perl.
Phys. Rev., Vol. 108, No. 4, 1036-9 (Nov. 15, 1957).

The associated production of strange particles by 1.1 BeV kinetic energy π^-mesons by the reactions

$$(1)\ \pi^- + p \rightarrow \Sigma^- + K^+,$$
$$(2)\ \pi^- + p \rightarrow \Lambda^0 + \theta^0,$$
$$(3)\ \pi^- + p \rightarrow \Sigma^0 + \theta^0,$$

was studied in a 12 in. propane bubble-chamber. The total cross-sections in hydrogen for the above reactions are 0.17 ± 0.04 mb, 0.22 ± 0.06 mb, respectively. In the π^-–p centre of mass, the Σ^- is produced in the forward direction while the Λ^0 and Σ^0 are produced in the backward direction. Lifetimes for the Σ^-, Λ^0, and θ^0 are found to be $(1.67_{-0.28}{}^{+0.48}) \times 10^{-10}$ sec, $(2.24_{-0.48}{}^{+0.79}) \times 10^{-10}$ sec, and $(0.74_{-0.15}{}^{+0.21}) \times 10^{-10}$ sec, respectively. From various angular distributions of decay products, it was found that the data are consistent with spin $\frac{1}{2}$ for the Λ^0 and Σ^- and spin 0 for the θ^0. The data are also consistent with parity conservation in strange-particle decay. A.

539.12

1890. PRODUCTION OF STRANGE PARTICLES BY π^-—p INTERACTIONS NEAR THRESHOLD. L.B.Leipuner and R.K.Adair. Phys. Rev., Vol. 109, No. 4, 1358-63 (Feb. 15, 1958).

Observations were made, in a liquid hydrogen bubble chamber, of the production and decay of strange particles produced by the interaction of 960 MeV π^- mesons with protons. The total strange particle production cross-section was measured to be 1.02 ± 0.20 millibarns. The cross-section is 0.58 ± 0.12 millibarn for Λ^0—θ^0 production, 0.35 ± 0.09 millibarn for Σ^0—K^+ production, and is 0.09 ± 0.04 millibarn for Σ^-—K^+ particles. Production angular distribution were peaked somewhat backwards for Σ^0 and Λ^0 hyperons. These cross-sections, together with other data, are interpreted as indicating the existence of a very strong interaction for the production of strange particles which extends over a small radius. The decay products of the Λ^0 hyperons from Λ^0—θ^0 production were preferentially aligned with the incoming beam, a result suggesting a spin of ½ for the Λ^0. Decay distributions for Λ^0 particles resulting from Σ^0 decay, and for θ^0 mesons, were consistent with isotropy. A.

NUCLEUS

539.14 : 539.17

1891. NEUTRONS AND NUCLEAR STRUCTURE. D.J.Hughes. Physica, Vol. 22, No. 11, 994-1008 (Nov., 1956).

"Amsterdam Nuclear Reactions Conference". In the past few years slow neutron spectrometers of greatly improved resolving power have been developed at many laboratories throughout the world. During the same period advances in techniques of data analysis have aided in producing the information now available on hundreds of neutron resonances. The manner in which the parameters of these resonances give valuable information on nuclear structure is described. The experimental findings are reviewed and particular emphasis paid to their bearing on current theoretical nuclear models. The following aspects are emphasized. (1) The radiation widths of nuclear energy levels and their relationship to theoretical transition probabilities. (2) The size distributions of neutron widths of levels and recent theoretical treatments of these distributions. (3) The average spacings of levels for different nuclei as well as the apparent non-random distribution of spacings for individual nuclei. (4) The probability of compound nucleus formation, or strength function, compared to recent calculations based on the cloudy crystal nuclear model. (5) Recent determinations of the nuclear radius at high and low neutron energies. A.

539.14

1892. VELOCITY-DEPENDENT FORCES AND NUCLEAR STRUCTURE. II. SPIN-DEPENDENT FORCES. M.Moshinsky. Phys. Rev., Vol. 109, No. 3, 933-41 (Feb. 1, 1958).

For Pt I see Abstr. 5542 (1957). Recent investigations have shown the presence of velocity-dependent forces in the two-nucleon interaction, increasing the number of parameters in the two-nucleon potential, and making more difficult the determination of these parameters in a unique way. In view of the successes of the shell model and of the assumptions that the same interactions hold between nucleons inside nuclear matter as between free nucleons, it is of interest to explore the possible restrictions on the two-nucleon potential that follow from level arrangements and separations in nuclear shell theory. In the present paper this exploration is carried out for velocity-dependent forces, starting with the two-body spin-orbit force, two forms of which have recently been proposed, and considering also the simplest velocity-dependent forces that depend on the second power of the momentum, which include the velocity-dependent tensor force recently introduced by Breit. The two-body spin-orbit force of Gammel and Thaler has a very short range, and, taking advantage of this fact it is shown that the interaction energy for two nucleons in the same shell is proportional to the interaction energy for the zero-range velocity-dependent central force discussed previously by the author. The simple expression for the interaction energy allows the level separation due to the spin-orbit force of Gammel and Thaler to be compared with that due to the spin-o bit force of Signell and Marshak. The effects of both types of spin-orbit forces are also compared with the interaction energy due to the central even singlet force of Gammel, Christian, and Thaler. A velocity-dependent central force that acts only in the triplet state is analysed. The velocity dependent tensor potential in the long-range approximation is discussed and it is shown that the restrictions that follow on the strength of this potential from the assumption that the separation between levels should be small compared with the separation between shells. The velocity-dependent tensor potential in the short-range approximation is also discussed, and restrictions obtained on the product of strength and range of this potential. The interaction energies for all short-range velocity-dependent potentials show similarities, suggesting the possibility of finding simple closed expressions for the interaction energies for all short-range forces. A.

539.14

1893. INNER SHELL STRUCTURE OF NUCLEI. H.Tyrén, T.A.J.Maris and P.Hillman. Nuovo Cimento, Vol. 6, No. 6, 1507-9 (Dec., 1957).

The coincidence measurement of the total energy carried away by the two protons in a high-energy (p,2p) reaction is proposed as an experimental method of investigating the structure of the inner shells of nuclei (and the validity of the "quasi-elastic" approximation developed to deal with such high-energy collisions). Preliminary results for 185 MeV protons on Li, C, Al are presented. In Li^6, a broad maximum at about 20 MeV may correspond to the binding energy of a proton in the α-core. J.Lascoux

539.14

1894. ANGULAR MOMENTUM COUPLING IN ODD-ODD NUCLEI. S.P.Pandya. Phys. Rev., Vol. 108, No. 5, 1312-14 (Dec. 1, 1957).

Some general results are derived for the odd-group model of odd-odd nuclei and used to discuss the validity of the model. A.

539.14

1895. COLLECTIVE MOTION IN A MODIFIED SHELL MODEL. A.Russek. Phys. Rev., Vol. 109, No. 2, 487-98 (Jan. 15, 1958).

Under certain conditions it is possible to ascribe an approximate nuclear surface to an independent-particle nuclear wave-function, thereby achieving a means with which to describe the collective coordinates of a nuclear wave-function that is expanded in terms of independent-particle states. By using this concept, a modification of the shell-model wave-function is constructed which exhibits properties of collective motion. The collective aspects of the model are quite similar to the spheroidal-core model of Rainwater except that the core deformations are not restricted to zero- and second-order spherical harmonics. However, since the wave-function for the deformed core here presented is expanded in terms of individual-particle states with quantum number nljm, a number of effects can be studied, concerning the deformed core, that were previously inaccessible. In the first place, the Pauli exclusion principle is found to suppress partially the collective deformation. Calculations show that the Y_2-mode of deformation, for example, is suppressed by about 28% for a typical heavy nucleus. Secondly, the contribution of the individual nucleon excitation energies to the over-all energy of the Y_2 mode of deformation is found to make the nucleus considerably more rigid against collective deformation of this type than is indicated by considering the core to be a liquid drop with a surface tension given by the semiempirical binding energy formula. Finally, a method is outlined, using the definition of nuclear surface here presented, for obtaining a self-consistent static wave-function by means of rough analogue to the Hartree—Fock procedure. A.

539.14

1896. INTRODUCTION TO THE BRUECKNER THEORY. H.A.Bethe. Physica, Vol. 22, No. 11, 987-93 (Nov., 1956).

"Amsterdam Nuclear Reactions Conference". The shell model and the related cloudy-crystal-ball model have had great successes but until recently it was not possible to derive these models from the known forces between two nucleons. Certain high-energy processes show that the nucleon—nucleon forces continue to act inside a complex nucleus. Brueckner's theory provides the desired basis for the shell model. It is a self-consistent field method which may be started by choosing a potential depending on velocity and position $(r'|V|r)$. The wave-functions of the individual nucleons in this potential are calculated; a Slater determinant of such functions is called the "model wave-function" of the nucleus. The actual wave-function Ψ is obtained from Φ by permitting all pairs of nucleons to scatter each other. It is then shown that this wave-function Ψ solves the complete Schrödinger equation of the nucleus with great accuracy. To achieve this result, it is essential that the integral equation for the scattering of a pair of nucleons be solved exactly, in the average potential provided by the other nucleons. For the convergence of the method the exclusion principle is of the greatest

importance. The method justifies essentially the method of Lane and Wandel for calculating the imaginary part of the potential of Weisskopf et al., and thus justifies the cloudy-crystal-ball theory. It leads to a procedure for calculating nuclear levels similar to that used in standard shell-model theory, except that interaction with configurations involving excited shells is already contained in the first-order energy. A.

539.14 : 539.12

1897. CALCULATION OF THE POLARIZATION OF NEUTRONS IN A NUCLEAR MODEL WITH A SMOOTH EDGE.
P.É.Nemirovskiĭ and Yu.P.Elagin.
Zh. éksper. teor. Fiz., Vol. 32, No. 6, 1583 (1957). In Russian.

Taking the spin–orbit potential as proportional to

$$\frac{1}{x}\frac{dV}{dx}(\vec{\sigma}.\vec{L})$$

the polarization in the 90° scattering of 400 keV neutrons is calculated and compared with experiment for a wide range of A. Good agreement is obtained for a ratio of imaginary to real parts of the central potential of 0.05 to 0.1. G.E.Brown

539.14

1898. THE OPTICAL AND SHELL MODELS OF A NUCLEUS.
P.É.Nemirovskiĭ.
Zh. éksper. teor. Fiz., Vol. 33, No. 3(9), 746-9 (1957). In Russian.

Bound states of a neutron are investigated in a potential field whose parameters are derived from the optical model of a nucleus possessing spin–orbital interaction. Agreement with the experimental data was obtained for the sequence of single-particle levels in nuclei which consist of a closed shell and one particle. A.

539.14

1899. NUCLEAR MOMENTS OF INERTIA. H.M.Foley.
Nuovo Cimento, Vol. 7, No. 2, 244-5 (Jan. 16, 1958).

The formula of Skyrme (Abstr. 7304/1957), used for the calculation of the moments of inertia of heavy nuclei, is criticized. It is shown to be equivalent to a simple but crude approximation to the Inglis "cranking model" formula. In Skyrme's simplified formula, the "exchange" two-particle matrix elements are unjustifiably neglected in comparison with "direct" matrix elements of comparable magnitude, and therefore this does not lead to reliable results. M.J.Kearsley

539.14

1900. NUCLEONIC BINDING STATES IN NONSPHERICAL NUCLEI: ASYMPTOTIC REPRESENTATION. A.J.Rassey.
Phys. Rev., Vol. 109, No. 3, 949-57 (Feb. 1, 1958).

An alternative description is given for Nilsson's analysis of nucleonic motion in a strongly deformed nuclear field. The aim is to obtain the single-particle states for the region of strong deformation in terms of a representation which is especially suited for that region in contrast to the spherical representation used by Nilsson. The eigenvectors of a 3-dimensional anisotropic harmonic oscillator (H.O.) are used as a basic set to calculate the single-particle wavefunctions and energy eigenvalues. Two immediate advantages of choosing this basic set are: first, the matrix elements between single-particle states are expressible in terms of the rather simple analytic expressions obtained for these matrix elements in the H.O. representation and second, the expansion of the particle wavefunctions generally is rather pure, so that in many instances the leading term in the expansion is sufficient for calculations. Thus, good approximate calculations are easily obtainable. The high degree of purity of state has been taken advantage of previously by several authors to classify states in the strong-deformation region using the "almost good" quantum number of the basic set (asymptotic quantum numbers). Separate level spectra are given for protons and neutrons similar to the Mottleson and Nilsson scheme but more extensive (including some N = 7 shell neutron levels). A large gap at neutron number 152 offers a partial explanation of the closing of a subshell there previously interpreted by Ghiorso et at. from α-decay curves. New approximate transition selection rules are given for allowed and first-forbidden β-decay. For allowed transitions the relative speed varies approximately as $10^{-|\Delta N_z|}$. For first forbidden transitions, relative speeds are tabulated as functions of ΔN_r. The latter transitions are generally cut down by a factor $(10^{-5}\text{-}10^{-3})$ for $|\Delta N_r| \geq 2$. A.

539.14

1901. NUCLEAR SUBSHELLS AND DEFORMATION IN THE REGION BEYOND LEAD. N.N.Kolesnikov and A.P.Krylova.
Zh. éksper. teor. Fiz., Vol. 33, No. 1(7), 274-7 (1957). In Russian.

Surveys binding energies for nuclides having Z in the range 82-100, and A (= Z + N) in the range 239-255. The energy of the "last" neutron in 4n + 1 or 4n + 3 nuclei can be interpreted in terms of a deformation of the potential well associated with the stable 4n configuration. J.W.Gardner

539.14

1902. NUCLEAR SPINS AND MAGNETIC DIPOLE MOMENTS OF 50-DAY In^{114m} AND 54-MIN In^{116m}. L.S.Goodman and S.Wexler.
Phys. Rev., Vol. 108, No. 6, 1524-6 (Dec. 15, 1957).

The nuclear spins and moments were measured in an atomic beam magnetic resonance apparatus. The spins were 5ħ for both nuclides. Magnetic moments of 4.7 ± 0.1 nuclear magnetons for In^{114m} and 4.4 ± 0.1 n.m. for In^{116m} were obtained. Both moments are shown to be positive. Multiple-quantum transitions were observed, and their effect on the accuracy of the results is discussed. A.

539.14

1903. POLARIZATION OF PROTONS SCATTERED ON O^{16}. SPIN AND PARITY OF THE 3.11 MeV LEVEL IN THE F^{17} NUCLEUS.
P.V.Sorokin, A.K.Val'ter, B.V.Gavrilovskiĭ, K.V.Karadzhev, V.I.Man'ko and A.Ya.Taranov.
Zh. éksper. teor. Fiz., Vol. 33, No. 3(9), 606-9 (1957). In Russian.

Polarization of protons scattered on O^{16} nuclei is investigated in the 2.6–2.8 MeV energy range. The measured value of the polarization, its resonance character and sign imply that the 3.11 MeV nuclear level in F^{17} has the characteristics $(1/2)^-$. A.

539.14

1904. CLASSIFICATION OF NUCLEAR MAGNETIC MOMENTS.
I.A.Valsman.
Zh. éksper. teor. Fiz., Vol. 33, No. 2(8), 412-15 (1957). In Russian.

It is proposed that the regions of maximal concentration of the nuclear magnetic moment values, plotted against spin, be defined by introducing, along with the Schmidt (Z. Phys., Vol. 106, 358, 1937) and Dirac (Abstr. 9636/1951) lines, some new lines as boundaries of these regions. Empirical data are presented as a proof of physical significance of these lines. Quenching of the "anomalous" part of the nucleon magnetic moment in nuclear matter, which occurs on deformation of the nucleus, is found to be more important in formation of the nuclear magnetic moment. A.

539.14

1905. QUADRUPOLE MOMENTS OF NUCLEI. A.N.Kushnirenko.
Dokl. Akad. Nauk SSSR, Vol. 117, No. 6, 963-4 (1957). In Russian.

The problem is treated within the framework of the shell model. The wave-function of the nucleus is represented by a linear combination of Slater determinants, composed of the one-nucleon wavefunctions, assuming strong spin–orbit coupling. The expansion coefficients were determined by utilizing the conservation laws for the z-component of the angular momentum, for the square of the angular momentum and for the square of the isobaric spin of the nucleus. By making use of general formulae an expression is obtained for the electric quadrupole moment of nuclei. Numerical results are given for twelve light and medium-weight nuclei, showing in general fair agreement with the (usually rather poor) experimental data. P.Roman

539.14

1906. THE THREE-BODY NUCLEAR INTERACTION IN K-40.
S.P.Pandya and J.B.French.
Ann. Phys. (New York), Vol. 2, No. 2, 166-75 (Aug., 1957).

An estimate of the effective three-body nuclear interaction between the nucleons outside closed subshells in K^{40} is made by comparing the low-lying energy levels of Cl^{38} and K^{40}. Use is made of the fact that, in jj coupling, and for an arbitrary two-body interaction, the $d_{3/2}^{\pm 1} f_{7/2}$ levels of one nucleus may be calculated from those of the other. After making a plausible calculation of the effects due to departures from the pure coupling scheme, a residual discrepancy is found, between prediction and experiment which can be reasonably explained by invoking a repulsive three-body interaction. An argument, based on detailed features of the interconfiguration effects, suggests indeed that such a three-body interaction is required; if this is assumed to be of short range, its magnitude is such that it contributes between 50 and 250 keV (for different J values) to the energy of the four outside nucleons in K^{40}. These magnitudes should, at least, define a reasonable upper limit to the allowable three-body interaction. A.

539.14 : 539.17

1907. THE LOW ENERGY NUCLEAR EXCITATION SPECTRUM.
A.Bohr.
Physica, Vol. 22, No. 11, 959-68 (Nov., 1956).

"Amsterdam Nuclear Reactions Conference". Various types of

nuclear reactions yield information on different aspects of nuclear structure. Inelastic scattering reactions which proceed by direct interaction are especially suited for the study of collective modes of excitation of the nucleus. Most quantitative information is obtained from Coulomb excitation processes. The evidence available from low-energy nuclear spectra is summarized. For even–even nuclei, the first few excited levels can in most cases be rather well described in terms of collective modes of motion. In odd-A (or odd–odd) nuclei, the relevant degrees of freedom include also those of the last nucleon(s). The collective modes correspond to oscillations of the nuclear shape and are influenced in an essential manner by the shell structure. For configurations with relatively few particles in unfilled shells, the collective excitations represent vibrations about a spherical equilibrium shape. If the nucleus contains sufficiently many particles in unfilled shells, an ellipsoidal equilibrium shape results. The collective excitations then separate into vibrations about the equilibrium shape and rotations with preservation of shape. While the dominating shape oscillations and deformations are of quadrupole type and give rise to excitations with no parity change, evidence has also recently become available on collective excitations of odd parity. A.

539.14

1908. COULOMB EXCITATION. T.Huus.
Physica, Vol. 22, No. 11, 1027-38 (Nov., 1956).

"Amsterdam Nuclear Reactions Conference". The methods employed for the observation of the excitations are mentioned, as well as the relative significance of various background processes. The experimental verification of the theory is demonstrated by a comparison with typical measurements. The systematic trends of the data are illustrated by figures which show the variations of some of the collective nuclear parameters derived from the measured quantities. A.

539.14

1909. FIRST EXCITED LEVELS OF AXIALLY-SYMMETRIC EVEN-EVEN NUCLEI. G.F.Filippov.
Dokl. Akad. Nauk SSSR, Vol. 115, No. 4, 696-8 (1957). In Russian.

An approximate solution to the Schrödinger equation for the collective model of heavy nuclei is obtained for the rotation–vibration motion with strong coupling, in the case of axially symmetric even-even nuclei. The axial symmetry clearly applies to the first excited levels. A graph is given plotting the calculated energy curves as functions of the dynamical parameters of the model, and shows fair agreement with experimental evidence for $A > 70$ nuclei. P.Roman

539.14

1910. VELOCITY-DEPENDENT NUCLEAR INTERACTION. II. LEVEL SCHEMES. W.E.Frahn and R.H.Lemmer.
Nuovo Cimento, Vol. 6, No. 5, 1221-4 (Nov., 1957).

The effect of non-local interactions is described by adding a "generalized kinetic energy operator" to a (local) isotropic harmonic oscillator potential (Abstr. 8765/1957). By choosing an effective mass $M^* = 0.5\ M_0$, the level spacings and well-depth are doubled, and in addition the (n,l) degeneracy of the oscillator levels is removed, the higher angular momentum states being more bound than the lower l-states. A Thomas type spin–orbit coupling term is then added and neutron level schemes are calculated which show a close similarity to those obtained by Ross, Lawson and Mark (Abstr. 2521/1957). P.K.Kabir

539.14

1911. ONE-PARTICLE LEVELS WITH SPIN–ORBIT INTERACTION ACCORDING TO THE SHELL MODEL FOR NUCLEI. A.Schröder.
Nuovo Cimento, Vol. 7, No. 4, 461-90 (Feb. 16, 1958).

The shell model of nuclei is considered, and the average potentials for protons and neutrons are calculated on a phenomenological basis. Different assumptions about the types of spin–orbit coupling and their magnitudes are treated in the one-particle picture. Their relative influence on the one-particle levels is discussed for almost the greatest part of the periodic system (above $A \cong 40$). Calculations show that a spin–orbit interaction $-\lambda(\hbar/m_\pi c)^2(1/r)(d/dr)V(r)\cdot(ls/\hbar^2)$ with only one fixed parameter λ leads to consistent results in one-particle levels: magic numbers are reproduced. The diffuse boundary potentials V(r) derived for neutrons and protons separately are in agreement with those derivable from elastic scattering experiments in the lowest energy limit. A.

539.14 : 539.166.2

ENERGY LEVELS IN Rh^{103}. See Abstr. 1253

539.14 : 539.17

ENERGY LEVELS IN N^{14}. See Abstr. 1261

539.14

1912. LIFETIME OF THE 3.56 MeV STATE OF LITHIUM 6. H.J.Rose and E.K.Warburton.
Phil. Mag. (Eighth Ser.), Vol. 2, 1468-71 (Dec., 1957).

Measurement of the Doppler shift of the 3.5 MeV γ-ray excited in the $Be^9(p,\alpha\gamma)Li^6$ reaction, shows the lifetime of this state to be less than 3×10^{-14} sec. It is concluded that the transition is predominantly M 1. M.A.Grace

539.14

1913. A METHOD OF MEASURING THE LIFETIMES OF EXCITED STATES OF ATOMIC NUCLEI. A.F.Tulinov.
Zh. éksper. teor. Fiz., Vol. 32, No. 6, 1568-70 (1957). In Russian.

It is suggested that a measurement of the angular distribution of nuclear recoils, after they have passed through a retarding layer, will yield information about lifetimes in the range 10^{-12}-10^{-14} seconds. W.O.Lock

539.14

1914. A NEW FORM OF ISOMERISM IN Eu^{153}. L.K.Peker.
Zh. éksper. teor. Fiz., Vol. 33, No. 1(7), 291-3 (1957). In Russian.

The small probability for quadrupole transitions between the 1– isomeric and 3– ground states and other peculiarities of this nucleus can be explained by taking the ground state to have a spherical form and the isomeric state to be ellipsoidal. G.E.Brown

539.14

1915. ANOMALOUS DECAY OF A HYPERNUCLEUS. A.P.Grigor'ev, É.P.Toporkova and A.I.Fesenko.
Zh. éksper. teor. Fiz., Vol. 32, No. 6, 1589 (1957). In Russian.

In an emulsion camera irradiated by cosmic rays, decay of a hypernucleus into three charged particles is observed. Analysis of these indicated that the decay went by one of the schemes

$$(He_2^5)^* \rightarrow H_1^1 + K^- + n + He_2^3 + (103 \pm 5)\ \text{MeV},$$

or

$$(He_2^6)^* \rightarrow H_1^1 + K^- + n + He_2^4 + (110 \pm 6)\ \text{MeV}.$$

G.E.Brown

RADIOACTIVITY

539.16.08

1916. CARBON DIOXIDE PROPORTIONAL COUNTING FOR NATURAL RADIOCARBON MEASUREMENTS. H.G.Östlund.
Ark. Kemi, Vol. 12, Paper 6, 69-78 (1957).

A modified method for the preparation and purification of carbon dioxide for use in a proportional counting tube, and the apparatus for radiocarbon age determinations are described. The stability and reproducibility of the apparatus is discussed, and statistical aspects on the statement of errors and of limit age are given. C^{13}/C^{12} ratios for groups of common materials for dating have been measured and an objective test for the reliability of the whole radiocarbon dating method by measurements of Sequoia tree-rings is reported. A.

539.16.08

1917. ON THE USE OF PLASTIC SCINTILLATORS FOR DOSE MEASUREMENTS. I.M.Rozman and K.G.Zimmer.
Internat. J. appl. Radiation and Isotopes, Vol. 3, No. 1, 43 (1958). English translation of article in: Atomnaya Energiya, Vol. 2, No. 1, 70 (1957). In Russian.

The proportionality between dose rate and the resulting luminescent intensity has been investigated in two scintillators based on polystyrene, which is known to be highly radiation resistant. One phosphor contained added tetraphenylbutadiene (1.5% by weight), the other contained 0.02% by weight of tetraphenylbutadiene together with 3% by weight of p-terphenyl. Both α-particle and β-particle excitation was employed. The range of dose rate investigated was up to 10^5 erg.g^{-1}.sec^{-1} for β-rays and 10^6 erg.g^{-1}.sec^{-1} (10^4 r. equiv./sec) for α-rays. Proportionality between dose rate and luminescence was found to be maintained. N.H.Gale

539.163

1918. DECAY OF ^{152}Eu AND THE UNIFIED NUCLEAR MODEL. S.K.Bhattacherjee, T.D.Nainan, S.Raman and B.Sahai.
Nuovo Cimento, Vol. 7, No. 4, 501-23 (Feb. 16, 1958).

The radiations from Eu^{152} (half-life 13 yrs) were investigated using an intermediate image spectrometer, a magnetic thin lens

spectrometer and a coincidence scintillation spectrometer. Three β-groups are present with end-points (1450 ± 25), (1040 ± 20), (710 ± 20) keV; the highest energy group exhibits an α-shape. γ-ray investigations showed that the following γ-rays are present: 101(5), 121 (88), 244 (30), (315 (4), 344 (100), 410 (9), 442 (4), 710 (13), 770 (77), 888 (14), 970 (89), 1090 (96), 1127 (96), and 1410 (135) keV. K-conversion coefficients were estimated for most of these transitions and multipole orders were assigned. X-ray-γ, $\gamma-\gamma$ and $\beta-\gamma$ coincidence experiments allow the decay scheme of Eu^{152} to be constructed. The difference in level structure in Sm^{152} (N = 90) and Gd^{152} (N = 88) is evident from the experimental results. The first three excited states at 121, 365 and 807 keV in Sm^{152} are identified as the three members of the ground state rotational band (K = 0); the levels at 1090 and 1248 keV having I = 2+, and 3+ respectively are shown to be the quadrupole γ-vibrational states corresponding to K = 2. The highest excited state in Sm^{152} is at 1417 keV and is most likely fed entirely by L-capture; this is the only odd-parity state in Sm^{152} having the character I = 1 −. The levels in Gd^{152} at 344 and 754 keV both with I = 2+, reached by β^--decay, are characteristic of the collective vibrations of the electric quadrupole type about a spherical equilibrium shape. The level at 1114 keV in Gd^{152} has the character I = 3 − and is interpreted as due to the octupole vibrations. The ground state of Eu^{152} is assigned the spin I = 4 −; the branching ratios and the transition probabilities for the β^--groups and electron capture transitions are calculated. The experimental results are consistent with the predictions of the unified nuclear model. A.

539.163

1919. RADIONUCLIDE K^{37}. C.R.Sun and B.T.Wright.
Phys. Rev., Vol. 109, No. 1, 109-12 (Jan. 1, 1958).

K^{37} was produced by a (p,α) reaction on Ca^{40}, using 12.8 MeV protons accelerated in a 20 MeV synchrocyclotron. The half-life of this activity was found to be 1.2 ± 0.12 sec. With a double-channel magnetic spectrometer the end point of the β-spectrum was determined as 5.10 ± 0.07 MeV. The ft value determined as 4150 ± 500 sec is within the expected range of the shell-model predictions. The Coulomb energy difference between K^{37} and A^{37} deduced from the end point agrees with Peaslee's analysis of the light nuclei. The pairing effect in Coulomb energies discussed by Carlson and Talmi is more clearly exhibited with the addition of the new data. A.

539.163

1920. DECAY OF Ce^{144} AND Pr^{144}.
R.L.Hickok, W.A.McKinley and S.C.Fultz.
Phys. Rev., Vol. 109, No. 1, 113-16 (Jan. 1, 1958).

The beta and gamma spectra from the decay of Ce^{144} and Pr^{144} was investigated by means of a magnetic-lens beta-spectrometer and single-channel scintillation spectrometers. Three partial beta-spectra with end-point energies and relative intensities of 184 keV (30%), 245 keV (5%), and 320 keV (65%) were observed for Ce^{144}. Gamma-rays and internal conversion lines corresponding to 54, 80, and 134 keV transitions were also detected. Internal conversion coefficients indicate an M1 multipolarity for the 80 and 134 keV transitions. Pr^{144} yields three partial beta-spectra with end-point energies and relative intensities of 0.90 MeV (2%), 2.45 MeV (3%), and 3.15 MeV (95%). Corresponding gamma-rays were also detected. Beta–gamma and gamma–gamma coincidence measurements substatiate the proposed decay scheme. A.

539.163.1

1921. THE HALF-LIFE OF THALLIUM 196 AND THE MULTIPOLARITY OF THE 426 keV TRANSITION IN MERCURY 196.
G.Andersson, J.O.Burgman and B.Jung.
Phil. Mag. (Eighth Ser.), Vol. 3, 105-6 (Jan., 1958).

A reinvestigation of the conversion lines of the 426 keV γ-ray excited in the decay of Tl^{196}($T_{1/2}$ = 1.8 ± 0.1 hr) gave a K/L ratio of 2.75 ± 0.28 in agreement with E2 assignment.

M.A.Grace

539.163.2

1922. RADIOACTIVE DECAY OF Se^{83}.
R.G.Cochran and W.W.Pratt.
Phys. Rev., Vol. 109, No. 3, 878-83 (Feb. 1, 1958).

An experimental investigation, using scintillation techniques, was made of the gamma-radiation emitted by the 69 sec isomer of Se^{83}. The Se^{83} was produced by irradiating selenium, enriched in the isotope Se^{82}, in the reactor neutron flux. Gamma-rays of energy 2.02 ± 0.05 MeV, 1.01 ± 0.02 MeV, 0.650 ± 0.005 MeV, and 0.350 ± 0.006 MeV were found, each with a (70 ± 1)-second half-life. Of these, only the 0.350 MeV gamma-ray was found in the 25 min isomer. From these measurements, together with beta–gamma and gamma–gamma coincidence measurements and a rough beta-ray end-point determination, a decay scheme is proposed for the 69 sec isomer of Se^{83}. A.

539.164

1923. α-DECAY OF Pu^{239}. G.I.Novikova, L.N.Kondrat'ev, Yu. P. Sobolev and L.L.Gol'din.
Zh. éksper. teor. Fiz., Vol. 32, No. 5, 1018-21 (1957). In Russian.

The α-spectrum of Pu^{239} has been investigated. Three new lines with energies at 5064 ± 2, 4999 ± 5 and 4917 ± 5 keV and intensities of (0.037 ± 0.005), (0.013 ± 0.005) and (0.005 ± 0.002)% have been detected. It is shown that the main α-line of Pu^{239} is related to the decay to an excited level of U^{235} with a spin 1/2. Three previously detected lines and two of the newly detected lines belong to the rotational band of this level. The existence of a metastable state of U^{235} with an excitation energy of ~ 3 keV is predicted. A doublet splitting parameter equal to a = −0.276 has been found.

A.

539.165 : 523.877

1924. B^{12}, C^{12}, AND THE RED GIANTS.
C.W.Cook, W.A.Fowler, C.C.Lauritsen and T.Lauritsen.
Phys. Rev., Vol. 107, No. 2, 508-15 (July 15, 1957).

Alpha-particle emission associated with the β-decay of B^{12} was detected and the energy spectrum investigated. These studies show that (1.3 ± 0.4)% of all decays of B^{12} lead to the second excited state of C^{12} and that this state breaks up predominantly into three alpha-particles with one alpha-particle and the ground state of Be^8 as an intermediate stage in the process. The most probable spin and parity assignments for the state appear to be $J = 0^+$, and analysis of the alpha-spectrum yields $Q(C^{12*}-Be^8-He^4)$ = 278 ± 4 keV, corresponding to an excitation energy in C^{12} of 7.653 ± 0.008 MeV. A new determination of the disintegration energy of Be^8 yields $Q(Be^8-2He^4)$ = 93.7 ± 0.9 keV and hence $Q(C^{12*}-3He^4)$ = 372 ± 4 keV. It is concluded from the general principle of reversibility of nuclear reactions, that the second excited state of C^{12} as predicted by Hoyle is of a suitable character to act as a stellar thermal resonance in the Salpeter process, $2He^4 \rightleftharpoons Be^8$; $Be^8(\alpha,\gamma)C^{12}$ under conditions expected in red giant stars. A.

539.165

1925. POLARIZED POSITRONS FROM Ga^{66} AND Cl^{34}.
M.Deutsch, B.Gittelman, R.W.Bauer, L.Grodzins and A.W.Sunyar.
Phys. Rev., Vol. 107, No. 6, 1733-4 (Sept. 15, 1957).

Positrons of selected energy were annihilated in a Lucite converter and the circular polarization of the high energy photons from 2-quantum annihilation was measured by transmission through magnetized iron. Effects up to about 8% were observed and show that for both nuclides σ.p is positive; for Ga^{66} the polarization appears to be complete. Since both are probably pure Fermi transitions these results indicate no basic difference between Fermi and Gamow–Teller transitions. M.A.Grace

539.165

1926. DETECTION OF Ga^{66} POSITRON POLARIZATION BY THE ANNIHILATION-IN-FLIGHT RATE IN POLARIZED MATTER.
S.Frankel, P.G.Hansen, O.Nathan and G.M.Temmer.
Phys. Rev., Vol. 108, No. 4, 1099-101 (Nov. 15, 1957).

By observing the change in this annihilation rate in magnetized iron it is concluded that the positrons from Ga^{66} ($0^+ \rightarrow 0^+$) are highly polarized in their direction of motion. M.A.Grace

539.165

1927. BETA DECAY OF Ru^{103}. R.L.Robinson and L.M.Langer.
Phys. Rev., Vol. 109, No. 4, 1255-7 (Feb. 15, 1958).

In an earlier investigation, the intense inner beta-spectrum of Ru^{103} was observed by Kondaiah to have an anomalous shape corresponding to a deficiency of electrons at low energy. This shape could not be explained by the generally accepted theory of beta decay. By use of a 4π beta-ray scintillation spectrometer, this beta group was studied in coincidence with the 495 keV gamma-ray. The Fermi plot of the data is now found to be linear down to 37 keV. The beta spectrum in coincidence with the 610 keV gamma-ray was also measured. By a comparison of the total decay energies of the inner beta-groups and their cascading gamma-rays, it is deduced that the 610 and 495 keV gamma-rays decay to the same energy level of Rh^{103}. The endpoint energies of the two beta-groups measured in coincidence with the 495 and 610 keV gamma-rays are respectively 227 ± 4 and 119 ± 4 keV. A.

539.165

1928. RELATIVISTIC THEORY OF RADIATIVE ORBITAL ELECTRON CAPTURE. P.C.Martin and R.J.Glauber.
Phys. Rev., Vol. 109, No. 4, 1307-25 (Feb. 15, 1958).

A fully relativistic treatment of the radiation accompanying nuclear capture of orbital electrons is presented. All effects of the electrostatic field surrounding the nucleus are taken into account. As a preliminary step, convenient representations for the electron

Green's function and initial state wave-function in a Coulomb field are derived. These forms, involving Dirac operators applied to scalar functions and free-particle angular eigenfunctions, are developed from the second-order Dirac equation. They are particularly useful for calculations since the procedures which make use of the properties of traces can be employed with them. With the aid of these representations the photon energy spectrum and polarization associated with allowed radiative K-capture are computed. Relativistic Coulomb corrections are shown to decrease the expected photon intensity significantly at all energies. Since their effect is not sensitively dependent on energy, the predicted shape of the spectrum is not greatly altered. The Coulomb field also influences the degree of polarization of the photons emitted, but has an appreciable effect only near the lower end of the spectrum. The influence of atomic screening on the capture from the K and L shells is also taken into account approximately. It is shown that screening considerably decreases the likelihood of radiative capture of all but the innermost electrons. Finally, the existing experimental evidence is reviewed and shown to agree with the theory presented. Some additional experimental tests are proposed. A.

539.165

1929. ON THE DETERMINATION OF THE ELECTRON CAPTURE DECAY ENERGY: ^{196}Au. R.K.Gupta.
Proc. Phys. Soc., Vol. 71, Pt 3, 330-4 (March, 1958).

A single-crystal scintillation spectrometer has been utilized to detect the triple summing, in the crystal, of three coincidence radiations. It has been shown that in an electron capture isotope the triple sum of two cascade γ-rays and K X-ray, which preceds the emission of γ-rays, can be used to calculate the ratio P_L/P_K for the transition to the second excited state of the daughter isotope. The ratio P_L/P_K can also be calculated by recording triple coincidence rate with two coincidence spectrometer units, by detecting the sum of two γ-rays in one and K X-rays in the other unit. These methods have been used to calculate the decay energy of Au^{196}. The decay energy has been found to be 911^{+55}_{-25} keV. A.

539.165

1930. THE β-SPECTRUM OF SULPHUR 35.
R.D.Connor and I.L.Fairweather.
Proc. Phys. Soc. A, Vol. 70, Pt 10, 769-70 (Oct., 1957).

A magnetic spectrometer was used to study the β-spectrum whose end-point was shown to be 167.4 ± 0.2 keV. M.A.Grace

539.165 : 539.166

1931. THE β-DECAY OF ^{185}W. B.H.Armitage and W.G.V.Rosser.
Proc. Phys. Soc., Vol. 71, Pt 3, 335-40 (March, 1958).

It is shown that the 56 keV γ-ray observed from natural tungsten irradiated in the pile does not arise from the decay of W^{185} as was suggested by Bisi, Terrani and Zappa (Abstr. 4012/1955). The γ-ray peak at 125 keV probably arises from a 0.005% branching ratio to the 125 keV excited level in Re^{185}. The continuous photon spectrum is interpreted quantitatively as internal plus external bremsstrahlung. A.

539.165 : 530.145

1932. β-RADIATION OF POLARIZED NUCLEI. G.R.Khutsishvili.
Zh. éksper. teor. Fiz., Vol. 32, No. 6, 1578-80 (1957). In Russian.

Angular distributions are obtained for a mixture of scalar and tensor and parity-conserving and parity-violating interactions. G.E.Brown

539.165.07 : 537.533.35

1933. AN IRON-FREE MAGNETIC BETA-RAY SPECTROMETER OF HIGH LUMINOSITY, RESOLVING POWER, AND PRECISION FOR THE STUDY OF DECAY SCHEMES OF THE HEAVY ISOTOPES.
J.W.M.DuMond.
Ann. Phys. (New York), Vol. 2, No. 4, 283-371 (Oct., 1957).

A complete detailed description of the purposes, theory, design, and techniques of operation of this high-precision, high-resolution, automatically recording instrument is presented. Some representative results are shown and figures of merit are obtained and displayed on Persico–Geoffrion charts for comparison with other instruments. A few examples of its performance are shown and a complete list of references to all nuclear decay schemes so far studied with the instrument is given. The present design represents the cumulative result of numerous modifications and improvements over five years of practical working experience since it was first put into operation. A.

539.165.2

1934. BETA DECAY OF C^{14} AND NUCLEAR FORCES.
W.M.Visscher and R.A.Ferrell.
Phys. Rev., Vol. 107, No. 3, 781-96 (Aug. 1, 1957).

The anomalously long lifetime of C^{14} is interpreted as being due to an accidental cancellation in the β-decay matrix element which is complete to about one part in 160. In the shell model with oscillator wave-functions, general two-nucleon interactions are introduced which are linear in the velocities and which satisfy various invariance requirements. As many of the force parameters are determined from low-energy experimental nuclear data as possible. The strength of the spin–orbit force is fixed by the p_3–p_1 splitting in N^{15}, while the tensor force is taken from meson theory. The conditions for cancellation are then shown to be satisfied, although uncertainties in the central force prevent an exact calculation of the wave-functions. These uncertainties are therefore eliminated by requiring cancellation, in addition to fitting the three lowest energy levels of N^{14}. The resulting N^{14} ground state wave-function is mainly D-state, containing only 13% P- and 3% S-component, and checks satisfactorily against various experimental properties of N^{14}. In addition, the β-decay of O^{14} is investigated and it is shown that the C^{14}–O^{14} difference in ft values is not adequately accounted for by the Coulomb repulsion theory of Jancovici and Talmi. The discrepancy is removed by including the slight difference in spin–orbit coupling strength for protons and neutrons, due to electromagnetic interaction with their magnetic moments. It is also pointed out that a nonlinearity of about 10% should be expected in the O^{14} Fermi–Kurie plot. In the appendices are a treatment of nucleon hole conjugation, an extension of a proof by Inglis on the impossibility of cancellation without the tensor force, a calculation of the n–α spin–orbit splitting, and an approximate treatment of the binding energy of the α-particle. A.

539.165.2

1935. TIME-REVERSAL INVARIANCE IN BETA DECAY.
R.R.Lewis.
Phys. Rev., Vol. 108, No. 3, 904-5 (Nov. 1, 1957).

The shape of the beta spectrum of RaE affords a good test of time-reversal invariance, without assuming a knowledge of the nuclear matrix elements. Analysed in terms of an S–T or V–A interaction, the result is that any non-invariant term must be small. J.C.Taylor

539.165.2

1936. FIERZ INTERFERENCE OF THE FERMI INTERACTIONS IN BETA DECAY. J.B.Gerhart.
Phys. Rev., Vol. 109, No. 3, 897-900 (Feb. 1, 1958).

The coupling constant combinations $(|C_S|^2+|C_S'|^2+|C_V|^2+|C_V'|^2)$ and $\mathrm{Re}(C_SC_V^* + C_S'C_V'^*)$ are evaluated for the beta-decay interaction by an analysis of data for $0 \rightarrow 0$ (no) transitions. A.

539.166

1937. RADIATIONS FROM Ba^{133}.
B.Crasemann, J.G.Pengra and I.E.Lindstrom.
Phys. Rev., Vol. 108, No. 6, 1500-5 (Dec. 15, 1957).

The decay of Ba^{133}, produced by pile neutron irradiation of Ba^{132}, was studied with a magnetic lens and scintillation spectrometers. Gamma-rays of 0.079, 0.302, and 0.355 MeV were measured, with relative intensities 1.00 : 0.71 : 2.1 and K-conversion coefficients of 1.3 ± 0.5, 0.11 ± 0.07, and 0.07 ± 0.05, respectively. Conversion electrons from weak transitions of energies 0.158 and 0.276 MeV were observed and assigned to Ba^{133}. Gamma–gamma coincidences were measured and a decay scheme is proposed. The K/L capture ratio for Ba^{133} is shown to be greater than 1.5. A.

539.166.2

1938. ELECTRIC MONOPOLE TRANSITIONS OF ATOMIC NUCLEI. D.P.Grechukhin.
Zh. éksper. teor. Fiz., Vol. 32, No. 5, 1036-49 (1957). In Russian.

Processes arising in E0-transitions in nuclei are considered. Formulae were obtained for the probabilities of shell electron conversion, pair production, two-photon transitions and the cross section for electron scattering involving excitation of E0 nuclear transition. The calculations were carried out with Coulomb functions of the electron taking into account the finite dimensions of the nucleus. The probability for conversion in an E0 nuclear transition is compared with the competing E2 and M1 nuclear transitions. Some estimates are given for the E0 nuclear transition matrix element for various single-particle and collective nuclear models. A.

539.166.83

1939. INTERNAL CONVERSION COEFFICIENTS OF γ RAYS IN Pu^{239}. G.T.Ewan, J.W.Knowles and D.R.MacKenzie.
Phys. Rev., Vol. 108, No. 5, 1308-11 (Dec. 1, 1957).

The K-conversion coefficients of the predominantly M1 γ-rays of 209.7, 228.2 and 277.9 keV following the β-decay of Np^{239} were measured using a curved crystal γ-ray spectrometer and a lens type β-ray spectrometer. The measured K-conversion coefficients are 1.76 ± 0.30, 1.60 ± 0.16 and 1.16 ± 0.12, respectively. A limit of less than 10% is placed on the admixture of E2 in these radiations from a study of the K/L and L_I:L_{II}:L_{III} conversion ratios. It is found, for Z = 94, that the measured conversion coefficients show better agreement with the M1 predictions of Sliv who allowed for finite nuclear size than with Rose et al. who assumed a point charge nucleus. In addition, the K-conversion coefficients of the 254.7, 285.5, 316.2 and 334.4 keV γ-rays of Pu^{239}, were measured to be 0.88 ± 0.32, 0.11 ± 0.02, 0.027 ± 0.005 and 0.025 ± 0.005 and the L_I and L_{II} conversion coefficients of the 106.4 keV γ ray to be 0.062 ± 0.007 and 0.071 ± 0.007, respectively. A.

539.166.83

1940. INTERNAL CONVERSION COEFFICIENTS OF M1 GAMMA RAYS OF Au^{199} AND Au^{195}. P.J.Cressman and R.G.Wilkinson.
Phys. Rev., Vol. 109, No. 3, 872-8 (Feb. 1, 1958).

An attempt was made to measure the internal conversion coefficients of the M1 + E2 radiations of Au^{199} and Au^{195} with sufficient accuracy to check the effect of the finite nuclear size on internal conversion in this region of Z. In the case of Au^{199} a direct comparison of the 158 keV pure E2 transition with the 208 keV M1 + E2 radiation was possible. Comparison of the gamma-ray intensities determined from scintillation spectrometry with conversion line intensities measured in a small shaped-field spectrometer yielded K, L, M, total shell coefficients. Comparison of these gamma-ray intensities with conversion line intensities photographically recorded in a higher resolution permanent-field spectrometer led to L-subshell coefficients. The results for the 208 keV transition are: a_K = 0.71 ± 0.05, a_L = 0.144 ± 0.01, a_{LI} = 0.114 ± 0.007, a_{LII} = = 0.0227 ± 0.0007, a_{LIII} = 0.0065 ± 0.0005, a_M = 0.042 ± 0.04, and a_{N+O} = 0.0083 ± 0.001. The empirical multiplicative factors f by which point-nucleus theoretical values are to be reduced, presumably due to the finite nuclear effect, and the E2 mixing ratio r have been determined: f_K = 0.762 ± 0.08, f_{LI} = 0.78 ± 0.13, f_{LII} = 1.00 ± 0.06, f_{LIII} = 1.0 and r = 0.11 ± 0.03. These results, insofar as they may be compared, are not inconsistent with Sliv's predictions (f_K = 0.8). An experimental value of 0.60 was found for the screening correction to Rose's M-shell coefficients for this Z and energy region. In the case of Au^{195} only permanent-field spectrograph measurements of the L- and M-subshell conversion of the 98 keV M1 + E2 transition were accurate enough for analysis. A comparison of the experimental ratios with the corresponding theoretical point-nucleus L and M values, the latter being corrected empirically for screening, gives: f_{LI} = 0.82 ± 0.10, f_{LII} = 0.73 ± 0.20, r = 0.014 ± 0.003. In this analysis it has been assumed that L_{III} shell correction is negligible. More accurate energy values and branching ratios were obtained. For the radiations of Au^{199} energies of 49.7, 158.3, and 208.0 keV were found with corresponding relative intensities 8%, 76%, and 16%. The Au^{195} energies and relative transition rates are 30.8, 98.5, and 129.4 keV, 20%, 72%, and 8%, respectively. Energy values are internally consistent to 0.10 keV. A.

539.166.83 : 539.165

1941. INVESTIGATION OF CONVERSION LINES IN THE β-SPECTRUM OF Ir^{192}. V.M.Kel'man, R.Ya.Metskhvarishvili, V.A.Romanov and V.V.Tuchkevich.
Zh. éksper. teor. Fiz., Vol. 33, No. 3(9), 588-94 (1957). In Russian.

A prism β-spectrometer with a resolution of 0.04% was used to study the conversion electron spectrum of excited Pt^{192} and Os^{192} nuclei produced in the decay of Ir^{192}. The conversion coefficient ratios K/L and L_I:L_{II}:L_{III} were determined for transition energies of 136.3, 201.3, 205.8, 295.9, 308.5, 316.5, 468.0 and 604.5 keV. For the most intense transitions the ratios K/M, M_I:M_{II}:M_{III}, K/N and K/O were also determined. All the investigated transitions were found to be E2 or E2 + M1. The amount of M1 admixture was determined. A.

539.167

1942. SEPARATION OF RaD AND RaE BY EVAPORATION IN VACUO OF THE OXIDES OBTAINED BY ANODIC DEPOSITION. J.Tousset and A.Moussa.
J. Phys. Radium, Vol. 18, No. 4, 284 (April, 1957). In French.

RaD was separated from the mixture of RaD and RaE obtained by anodic deposition from a nitric acid solution of RaD by evaporation in vacuo on to a Formvar film by heating the anode briefly to ~ 800°C. The contamination by RaE was never > 4%. A.O.Stanesby

539.167

1943. AN ISOTOPE OF GADOLINIUM WITH MASS NUMBER 146. I.A.Gusev, O.M.Lilova, A.N.Murin, B.K.Preobrazhenskiĭ and V.A.Yakovlev.
Zh. éksper. teor. Fiz., Vol. 32, No. 6, 1585 (1957). In Russian.

This was formed in the bombardment of tantalum by 660 MeV protons, and was identified by its decay into known isotopes of europium. G.E.Brown

NUCLEAR REACTIONS

539.17

1944. AMSTERDAM NUCLEAR REACTIONS CONFERENCE. GENERAL INTRODUCTION. H.A.Bethe.
Physica, Vol. 22, No. 11, 941-51 (Nov., 1956).

This conference was held in July, 1956. Abstracts of the main papers appear under their appropriate subjects.

539.17 : 539.14

1945. DIRECT INTERACTION THEORY OF INELASTIC SCATTERING. I. C.A.Levinson and M.K.Banerjee.
Ann. Phys. (New York), Vol. 2, No. 5, 471-98 (Nov., 1957).

The direct interaction theory of inelastic scattering of nucleons on nuclei is developed. The method of distorted waves is required since the plane wave approximation for the projectile is not sufficient for a detailed analysis of these processes. Several interesting selection rules are derived and comparison of these rules with experiments are presented. In particular, it is shown how information about level spins in nuclei can be derived from inelastic scattering experiments. A.

539.17 : 539.14

1946. DIRECT INTERACTION THEORY OF INELASTIC SCATTERING. II. ANGULAR CORRELATION OF GAMMA RAYS FOLLOWING INELASTIC SCATTERING.
M.K.Banerjee and C.A.Levinson.
Ann. Phys. (New York), Vol. 2, No. 5, 499-524 (Nov., 1957).

The angular correlation function of the gamma-rays, following inelastic scattering of protons via direct interaction, is calculated. The effects of the distortions of the plane waves on the angular correlation is discussed. It is shown that the angular correlation function depends on the spin exchange process and thus on the nuclear wave-function. Analysing the experimental data on $C^{12}(p,p')C^{12*}\gamma C^{12}$ angular correlation, it is found that the wave-functions describing the ground and the first excited state of C^{12} must be very close to the extreme j-j coupling limit. A.

539.17

1947. SOME PROPERTIES OF THE SHIFT AND PENETRATION FACTORS IN NUCLEAR REACTIONS.
F.W.Prosser, Jr and L.C.Biedenharn.
Phys. Rev., Vol. 109, No. 2, 413-17 (Jan. 15, 1958).

The shift and penetration factors are shown to have certain monotonic properties in the variables ρ, η and l for both positive and negative energies. The behaviour of the shift factor in the neighbourhood of zero energy (threshold) is discussed. A.

539.17

1948. THE FORMATION OF THE COMPOUND NUCLEUS. V.F.Weisskopf.
Physica, Vol. 22, No. 11, 952-8 (Nov., 1956).

"Amsterdam Nuclear Reactions Conference". The problem of the compound nucleus can be divided into two parts. One is the formation of a compound system and the second is the decay of the compound system into its products. Already progress has been made in respect to knowledge concerning the formation of the compound nucleus. Especially the optical model with a complex potential has given a tool to distinguish compound-system formation from potential scattering. Hence, some knowledge has been obtained as to the probability of compound formation as a function of the energy of the incident particle. In particular, the transition was observed from the small interaction known from the shell model to large interaction at higher energies. The detailed theoretical explanation of these effects is still unknown. However, the qualitative trend is easily understandable. The second problem of the decay of the compound system is a much more difficult one. Here the question is

raised as to whether the decay is independent of the way of formation. A critical discussion of this problem shows that the conditions for this independence will only rarely be fulfilled. Hence, conclusions based upon this independence are idealizations which cannot be expected to describe the details of the observed nuclear reactions. Deviations from the Bohr hypothesis of independence are caused not only by direct interactions between the incoming particle and the outgoing nucleon. They are also caused by the lack of "thermal" equilibrium in the compound state. Some general reasons for this conclusion are given. A.

539.17

1949. THE ANALYSIS OF DATA ON NUCLEAR SCATTERING OF CHARGED PARTICLES. R.F.Christy.
Physica, Vol. 22, No. 11, 1009-18 (Nov., 1956).

"Amsterdam Nuclear Reactions Conference". The elastic scattering of charged particles of energies up to a few MeV by nuclei is discussed. The point of view is the analysis and interpretation of the experimental data. Two general types of data are considered: broad resonances or non-resonant interactions and narrow resonances. In the case of broad resonances, only s-waves are treated, but the analysis covers the s-wave interactions quite generally and extracts the nuclear parameters in various forms. The narrow resonance treatment covers resonances of arbitrary l and J superposed on a region of s-wave interactions. The more complicated cases, where phase shifts for $l > 0$ are important and slowly varying, are not treated. A.

539.17

1950. CAPTURE REACTIONS. P.M.Endt.
Physica, Vol. 22, No. 11, 1062-8 (Nov., 1956).

"Amsterdam Nuclear Reactions Conference". Capture reactions are considered from the viewpoint of the nuclear spectroscopist. Especially important to him are the capture of neutrons, protons and alpha-particles, which may proceed through narrow resonances, offering a well defined initial state for the subsequent de-excitation process. Each of these particles mentioned has its own advantages and disadvantages, largely depending on particle energy and on the mass number region in which one is going to work. The γ-radiation produced at a resonance may be investigated through measurements of the γ-ray spectrum and its angular distribution, and through coincidence and angular correlation measurements. The theory is well established, and has been fully supported by experiment in a large number of cases. Complications in the interpretation may arise from interference between different resonances (if these are broad), and from mixing of different channel spins, of different orbital momenta of the incoming particle, and of different γ-ray multipolarities. Much use has been made of (p,γ) reactions on light elements. They offer an almost ideal opportunity for spin and parity determinations of resonance levels and lower levels. From γ-ray intensities it may be possible to test isobaric spin selection rules for E 1 radiation, or, inversely, to determine isobaric spins. A.

539.17

1951. AMSTERDAM NUCLEAR REACTIONS CONFERENCE. CONCLUSIONS. L.Rosenfeld.
Physica, Vol. 22, No. 11, 1115-23 (Nov., 1957).

539.17

1952. REACTIONS INVOLVING POLARIZED PARTICLES. M.I.Shirokov.
Zh. éksper. teor. Fiz., Vol. 32, No. 5, 1022-35 (1957). In Russian.

Statistical tensors of particles produced in reactions of the $a + b \rightarrow c + d$ or $a \rightarrow c + d$ type have been obtained in the most general case when the incident beam and target particles are in definite spin states. New selection rules are deduced which supplement the selection rules of Simon and Welton (Abstr. 5864/1953, 1681/1954). The first rule can be considered as a generalization of the rule that the polarization vector of the particles resulting in the reaction is perpendicular to the plane of the reaction if the incident beam and target are unpolarized. According to the second rule the statistical tensors of the resulting particles of the reaction defining the relative direction of the particle momentum are either purely real or purely imaginary if the incident beam and target are unpolarized. As a particular case the decay of particles of spin 1/2 and 0 is considered and it is shown that the polarization and angular distribution of these particles depend only on the spin and spin state of the decaying particle. A.

539.17

1953. COLLECTIVE EXCITATION OF EVEN-EVEN ATOMIC NUCLEI. A.S.Davýdov and G.F.Filippov.
Zh. éksper. teor. Fiz., Vol. 33, No. 3(9), 723-9 (1957). In Russian.

Collective excitation of axially symmetric even—even nuclei is investigated. It is shown that excitations of this kind can be divided into two classes: those which involve and those which do not involve appreciable changes in the nuclear quadrupole moment. The energy of collective excitations is expressed in terms of only two parameters. A.

539.17

1954. SOME REMARKS ON THE OPTICAL MODEL FOR NUCLEON—NUCLEUS ELASTIC SCATTERING. L.van Hove.
Physica, Vol. 22, No. 11, 979-86 (Nov., 1956).

"Amsterdam Nuclear Reactions Conference". A review is given of the published work on the analysis of high-energy nucleon scattering from complex nuclei on the basis of the quasi-optical model originally introduced by Fernbach, Serber and Taylor, with inclusion of polarization effects. A.

539.17

1955. MEDIUM ENERGY REACTIONS AND SCATTERING. P.C.Gugelot.
Physica, Vol. 22, No. 11, 1019-26 (Nov., 1956).

"Amsterdam Nuclear Reactions Conference". The interpretation of elastic proton scattering leads ot the assumption of a nuclear absorption potential which varies between 2 MeV and 10 MeV. The corresponding mean free path of a nucleon in nuclear matter is then of the same order of magnitude as the nuclear dimension. This result bears strongly on the interpretation of inelastic proton scattering and on proton or neutron induced reactions. The picture of the compound nucleus which depends on a strong, unhampered interaction between incoming nucleon and nucleus may have to be changed. Not only the proton surface interaction has to be taken into account, but one may have to consider the transparency of the target nucleus such that the (p,p') reaction becomes particularly probable if the residual states are similar to the initial states. On the other hand, if the final state cannot have any resemblance to the initial state as for instance for (p,α) reactions one would expect the shape of the spectrum to differ from the proton spectrum for inelastic scattering. The width for the re-emission of fast protons may be greater by several orders of magnitude than the width for the emission of fast α-particles. The ratio of the widths reduces to about one for low emission energy. A.

539.17

1956. HIGH ENERGY SCATTERING AND POLARIZATION. E.Segrè.
Physica, Vol. 22, No. 11, 1079-90 (Nov., 1956).

"Amsterdam Nuclear Reactions Conference". The experimental data for elastic scattering of protons on complex nuclei are reviewed, especially at the energies at which there are polarization experiments. The experimental results are compared with the calculations made with the complex potential well plus spin—orbit interaction model and some justification of this model on the basis of the nucleon scattering is reported. A description is given of the present state of n—p and p—p scattering problems, especially at 300 MeV where there are most complete data. In particular the polarization experiments for p—p in double and triple scattering add enough information to render the problem of the phase-shift determination overdetermined in principle. However, the experimental errors are such that several sets of phase-shifts are possible. The importance of the junction of the 300 MeV data with the data at lower energies is emphasized. The relation of the solution of the p—p problem to the n—p problem is also discussed. A.

539.17

1957. THE ELASTIC AND INELASTIC SCATTERING OF PROTONS BY SILICON.
G.W.Greenlees, L.G.Kuo, J.Lowe and M.Petravić.
Proc. Phys. Soc., Vol. 71, Pt 3, 347-50 (March, 1958).

Absolute differential cross-sections are given for the elastic scattering by silicon of 9.45 MeV, 9.28 MeV, 8.96 MeV, 8.55 MeV and 7.97 MeV protons for an angular range of 15^0—156^0 (centre-of-mass coordinates). The angular distributions show characteristic maxima and minima, the patterns varying slowly with energy as might be expected for scattering by a complex potential. Absolute differential cross-sections for the inelastic scattering of protons at these five energies from the 1.78 MeV level of Si^{28} are also given. All the inelastic angular distributions are asymmetric about 90^0 with a forward peaking. The magnitude of the asymmetry varies with energy and is greatest at 8.96 MeV. A.

539.17

1958. ENERGY DISTRIBUTION OF NEUTRONS EMITTED FROM BERYLLIUM BOMBARDED BY 680 MeV PROTONS.
V.S.Kiselev and V.B.Flyagin.
Zh. éksper. teor. Fiz., Vol. 32, No. 5, 962-4 (1957). In Russian.

The energy spectra of neutrons were measured in the laboratory system at angles of 0^0 and 18^0. A peak was detected in the 100-400 MeV region which was not observed at lower primary proton energies. The existence of this peak is explained by π-meson production processes. A.

539.17

1959. ON THE CROSS-SECTION FOR PRODUCTION OF MULTIPLY CHARGED PARTICLES IN THE INTERACTION BETWEEN PROTONS AND NUCLEI. O.V.Lozhkin.
Zh. éksper. teor. Fiz., Vol. 33, No. 2(8), 354-7 (1957). In Russian.

Nuclear emulsions were used to study the bombarding proton energy and atomic weight dependence of the cross-section for production of multiply charged ($Z \geq 4$) particles in nuclear disintegrations due to fast protons. The cross-section for production of particles possessing an energy greater than 1 -2 MeV per nucleon varies from 3 to 12×10^{-27} cm^2 for incident-particle energies lying between 300 -660 MeV, if heavy nuclei (Ag, Br) are disintegrated, and remains equal to 2×10^{-27} cm^2, if light nuclei (C, N, O) are disintegrated. For a given energy of the incident particles the cross-section of the reaction increases with increase of the mass number of the target nuclei. A.

539.17 : 539.12

PRODUCTION OF MESONS BY PROTONS. See Abstr. 1876-8

539.17 : 539.12

PRODUCTION OF Λ^0 PARTICLES IN LEAD AND CARBON BY 2.5 BeV PROTONS. See Abstr. 1888

539.17

1960. ANALYSIS OF NUCLEAR INTERACTIONS OF ENERGIES BETWEEN 1000 AND 100 000 BeV.
B.Edwards, J.Losty, D.H.Perkins, K.Pinkau and J.Reynolds.
Phil. Mag. (Eighth Ser.), Vol. 3, 237-66 (March, 1958).

Twenty nuclear interactions produced by protons and ten produced by α-particles of energies above 1000 BeV have been analysed. The proportion of pions amongst the secondaries is found to be 80% for the core and less than 70% for the wide angle tracks. The average transverse momentum resulting from the measurements is $p_T = 0.5$ BeV/c for pions and $p_T = 1$-2 BeV/c for heavy particles. It appears to be independent of angle of emission and primary energy. The multiplicity of the interaction, n_S shows no variation with primary energy; it varies, however, with the anisotropy of the angular distribution, and shows wide fluctuations at a fixed primary energy. The inelasticity, K, of the collisions is close to unity for secondary interactions of mean energy ~ 100 BeV and about 0.2 for jets produced by protons of energy ~10 000 BeV. At a fixed energy, K does not appear to be strongly dependent on n_S. None of the current theories appears capable of giving a satisfactory explanation of the experimental results, and an alternative model is proposed. A.

539.17

1961. NUCLEAR SCATTERING OF NUCLEONS AND ANTI-NUCLEONS. H.P.Duerr.
Phys. Rev., Vol. 109, No. 4, 1347-52 (Feb. 15, 1958).

Total cross-sections and reaction cross-sections for scattering of nucleons and antinucleons from nuclei are calculated in the W.K.B. approximation. The real part of the potential is the effective potential of the relativistic theory proposed in earlier papers, with a radial dependence consistent with the electron scattering results. The absorption coefficient is related to the observed particle–particle cross-sections in the usual fashion. The resulting cross-sections for nucleons agree quite well with the experimental data up to approximately 250 MeV. However, the high-energy nucleon total cross-section and the antinucleon cross-sections are too large. This discrepancy presents a real difficulty for the relativisitc theory. A.

539.17

1962. ON THE THEORY OF STRIPPING REACTIONS.
J.Horowitz.
Physica, Vol. 22, No. 11, 969-78 (Nov., 1956). In French.

"Amsterdam Nuclear Reactions Conference". The approximations made in the various intermediate energy stripping calculations are reviewed and discussed. In most cases the simple Butler theory represents the shape of the angular distribution well enough to allow unambiguous assignments in nuclear spectroscopy. The absolute value of the differential cross-sections which are proportional to the reduced widths are much more sensitive to the Coulomb forces and to the nuclear interactions. Bowcock's procedure for deriving the reduced width is discussed. The interference between compound nucleus formation and stripping, near a resonance, is also considered. Experimental and theoretical results on the polarization of the protons in a (d,p) reaction are presented. A.

539.17

1963. STRIPPING AND PICK-UP REACTIONS — EXPERIMENTAL. J.R.Holt.
Physica, Vol. 22, No. 11, 1069-78 (Nov., 1956).

"Amsterdam Nuclear Reactions Conference". Recent advances in the techniques for measuring angular distributions of protons and neutrons from deuteron stripping reactions are described. These involve magnetic analysis in the case of protons and the use of scintillation counters for neutrons. Little work has so far been done on pick-up reactions. The use of angular distributions for the assignment of spins and parities to resultant nuclear states requires a certain amount of care and experience; the nuclear radius is to some extent an adjustable parameter to be used with caution. Relative values of the stripping cross-section for different levels of the same nucleus often provide useful hints regarding the structure of the levels. Direct comparison of reduced widths of corresponding states of mirror nuclei have shown fair agreement. A considerable amount of experimental work is being done in an effort to throw some light on the mechanism of the stripping process. Measurements of excitation functions sometimes show resonances which are more prominent at the stripping peak that at large angles, indicating interference between stripping and some other process. Further useful information is being obtained from measurements of (d,pγ) angular correlations and of the polarization of the protons. A.

539.17

1964. ANGULAR DISTRIBUTIONS OF SOME INELASTICALLY SCATTERED DEUTERON GROUPS FROM ^{24}Mg AND ^{28}Si.
S.Hinds, R.Middleton and G.Parry.
Proc. Phys. Soc. A, Vol. 70, Pt 12, 900-2 (Dec., 1957).

With a bombarding energy of 8.9 MeV, angular distributions were measured for deuteron groups leading to the states at 1.368, 4.122 and 4.23 MeV in Mg^{24} and 1.78 MeV in Si^{28}. Only partial agreement with the theory of Huby and Newns is found. M.A.Grace

539.17

1965. THE DIFFERENTIAL CROSS SECTIONS FOR THE REACTIONS ^{14}N(d,p)^{15}N AND ^{14}N(d,α)^{12}C BETWEEN 600 AND 1000 keV. D.L.Booth, F.V.Price, D.Roaf and G.L.Salmon.
Proc. Phys. Soc., Vol. 71, Pt 3, 325-9 (March, 1958).

Using a thin gas target, the differential cross-sections for the two most energetic proton and alpha-groups have been measured; an expansion in the form $\Sigma a_n P_n(\cos\theta)$ has been fitted to the results. In no case was the value of a_n significant for $n > 3$, indicating that deuteron stripping is not important below 1 MeV bombarding energy. A.

539.17

1966. NEUTRONS FROM THE He^3 BOMBARDMENT OF B^{10}.
F.Ajzenberg-Selove, M.L.Bullock and E.Almqvist.
Phys. Rev., Vol. 108, No. 5, 1284-8 (Dec. 1, 1957).

The neutron spectrum from the $B^{10}(He^3,n)N^{12}$ reaction was studied at $E(He^3) = 2.54$ and 3.60 MeV by the method of proton recoils in nuclear emulsions. The Q-value of the $B^{10}(He^3,n)N^{12}$ reaction was measured to be 1.46 ± 0.06 MeV. The mass of N^{12} is then 12.02255 ± 0.00007 a.m.u. The data also indicate excited states of N^{12} at 1.06 ± 0.08, 1.56 ± 0.08, (1.97 ± 0.10), 2.35 ± 0.08, 3.18 ± 0.15, and 3.46 ± 0.15 MeV, in good agreement with the known levels of the mirror nucleus, B^{12}. At $E(He^3) = 2.54$ MeV, the angular distribution of the ground state neutrons is isotropic within statistics in the centre-of-mass system, while at $E(He^3) = 3.60$ MeV, the angular distribution is peaked forward: $I(0^0)/I(140^0) = 2.9 \pm 0.7$, in the centre-of-mass system. A.

539.17

1967. DIFFERENTIAL CROSS SECTIONS FOR THE $C^{12}(He^3,p)N^{14}$ REACTION.
R.L.Johnston, H.D.Holmgren, E.A.Wolicki and E.G.Illsley.
Phys. Rev., Vol. 109, No. 3, 884-7 (Feb. 1, 1958).

The differential cross-sections of the three highest energy proton groups from the $C^{12}(He^3,p)N^{14}$ reaction were measured at six angles as a function of incident He^3 energy from 2.0 to 5.0 MeV. Broad resonances were observed at 3.0, 3.6, 4.4, and 4.8 MeV in addition to those previously observed. The angular distributions are rather complex and not easily attributable to either a compound

nucleus or a direct interaction. The differential cross-sections were measured at closely spaced angular intervals from 7 to 158° in the centre-of-mass system for bombarding energies of 2.0 and 4.5 MeV. A.

539.17

1968. ENERGY LEVELS IN B^{10} IN THE REACTION $Li^6(\alpha,\gamma)B^{10}$. L.Meyer-Schützmeister and S.S.Hanna.
Phys. Rev., Vol. 108, No. 6, 1506-11 (Dec. 15, 1957).

The yield of the reaction $Li^6(\alpha,\gamma)B^{10}$ was measured as a function of bombarding energy from 0.7 up to 3.8 MeV. Five levels in B^{10} were found at excitation energies of 4.77, 5.11, 5.16, 5.91, and 6.02 MeV. Only the levels at 4.77 and 5.16 MeV have been observed previously in this reaction. Resonance widths, cross-sections, branching ratios, and angular distributions are given for the levels. Spin assignments of 2^+ (or possibly 3^+) to the 4.77 MeV level and 4^+ to the 6.02 MeV level are indicated by the evidence. For the other levels many spins are ruled out but definite assignments cannot be given. A.

539.17

1969. COULOMB EXCITATION OF Sb, Cs, AND Ba. L.W.Fagg.
Phys. Rev., Vol. 109, No. 1, 100-4 (Jan. 1, 1958).

Coulomb excitation of several nuclei in the region between A = 123 and 137 resulted in observation of the following gamma-rays: Sb^{123}, 161 and 376 keV; Cs^{133}, 82, 163, 302, and 385 keV; Ba^{130}, 359 keV; Ba^{132}, 470 keV; Ba^{135}, 218 keV; and Ba^{137}, 281 keV. Values of reduced transition probability for excitation are given for most of the above gamma-rays. In the case of Cs^{133}, absolute intensities and branching ratios are given for the gamma-rays in the decay of the upper excited states. Level schemes are proposed based on coincidence studies and excitation curves. A.

539.17

1970. INTERACTION BETWEEN NITROGEN AND GOLD NUCLEI. S.A.Baraboshkin, A.S.Karamyan and G.N.Flerov.
Zh. éksper. teor. Fiz., Vol. 32, No. 6, 1294-7 (1957). In Russian.

The dependence of the cross-sections on nitrogen energy was determined for the reactions Au (N, 4n), Au (N, 5n), Au (N, 6n). The irradiation was carried out at the internal probe of a cyclotron with monoenergetic ions accelerated up to 115 MeV. In accordance with the theory of competitive processes, curves with pronounced peaks have been obtained. A.

539.17

1971. YIELD OF CALIFORNIUM ISOTOPES IN THE INTERACTIONS BETWEEN CARBON IONS WITH URANIUM NUCLEI. Yu.B.Gerlit, L.I.Guseva, B.F.Myasoedov, N.I.Tarantin, K.V.Filippova and G.N.Flerov.
Zh. éksper. teor. Fiz., Vol. 33, No. 2(8), 339-42 (1957). In Russian.

The yield of the californium isotopes Cf^{246}, Cf^{245} and Cf^{244} produced in the reaction between 90 MeV carbon ions and a thick uranium target was investigated. The absolute californium yield per incident particle is 1.5×10^{-9} Cf^{246} nuclei, $\sim 3.0 \times 10^{-9}$ Cf^{245} nuclei and $\leq 9.10^{-11}$ Cf^{244} nuclei. Comparison of the obtained results with the cross-section for fission of uranium by carbon ions indicates that fission is 3.8×10^3 times more probable than neutron evaporation from the compound Cf^{250} nucleus. A.

539.17

1972. STRIPPING REACTION IN THE INTERACTION OF ACCELERATED N^{14} NITROGEN IONS WITH THE NUCLEI OF SOME ELEMENTS. V.V.Volkov, A.S.Pasyuk and G.N.Flerov.
Zh. éksper. teor. Fiz., Vol. 33, No. 3(9), 595-601 (1957). In Russian.

Formation of the radioactive nuclide N^{13} was observed when foils of Al, Ni, Cu, Ag, Sn and Cd were bombarded with ~ 100 MeV cyclotron-accelerated N^{14} ions. Measurements of the angular distribution showed that the N^{13} nuclei are emitted in a comparatively narrow angle range. The angle corresponding to maximal intensity increases with Z. If the energy or the bombarding particle exceeds the height of the Coulomb barrier the effective cross-section for production of N^{13} will weakly depend on the energy. The cross-section is equal to ~ 30 millibarns for Ni and ~ 12 millibarns for Al. A.

539.17

1973. NUCLEAR PHOTODISINTEGRATION. D.H.Wilkinson.
Physica, Vol. 22, No. 11, 1039-61 (Nov., 1956).

"Amsterdam Nuclear Reactions Conference". A survey is given of the chief mechanisms by which electromagnetic radiations interact with nuclei. The shell, collective and high momentum models are separated and their regions of applicability are approximately delimited. In particular the importance of high-momentum states for high energy photon interaction is emphasized. After comment on the success of the shell model in describing dipole transitions in light elements an examination is made of the "giant resonances" from the same point of view. After some discussion of earlier collective models of this phenomenon it is suggested that the absorption of gamma-rays in the closed shells of the nuclear core will give rise to a giant resonance. It is shown how such absorption is strong enough to accord with experiment and how there is a very strong clustering of such shell model transitions in resonance form. Difficulties with the absolute energy scale are discussed but not completely resolved. The widths and variations in width of the experimental giant resonance are satisfactorily accounted for. The "resonance direct" process by which a nucleon may be emitted from the nucleus in a single-particle state is described and it is pointed out that such emission leads to a roughly "Maxwellian" spectrum. The anomalous emission of protons from heavy nuclei is dealt with in detail and it is shown that the resonance direct mechanism accounts quantitatively for such emission from the points of view of absolute cross-section and also proton energy distribution. A.

539.17

1974. WIDTHS OF THE GIANT RESONANCE OF PHOTONUCLEAR REACTION. M.Soga and J.Fujita.
Nuovo Cimento, Vol. 6, No. 6, 1494-9 (Dec., 1957).

Wilkinson's treatment (preceding abstract) of the nuclear photoeffect using the shell model is extended by calculating the single particle absorption in a deformed nucleus (taken here as an infinite spheroidal well). The photon absorption lines of the spherical nucleus are split by the deformation, and spread over an energy region which is tentatively identified with the width of the giant resonance. This theoretical width is compared with Okamoto's calculation (Abstr.718/1957) and the results are found to be similar.

J.Lascoux

539.17 : 539.14

1975. PHOTODISINTEGRATION OF SODIUM BY $^7Li(p,\gamma)$ RADIATION. T.R.Ophel and I.F.Wright
Proc. Phys. Soc., Vol. 71, Pt 3, 389-97 (March, 1958).

A small thin NaI:Tl scintillator has been used as both source and detector of photoprotons produced in sodium [$Na^{23}(\gamma,p)$ reaction] by $Li^7(p,\gamma)$ radiation. This technique provides photoproton energy spectra of good resolution and high statistical precision. Spectra were obtained with both resonance and non-resonance radiation from the $Li^7(p,\gamma)$ reaction which permit identification of protons produced by the 17.6 MeV component of the incident radiation. These protons correspond to transitions to states in Ne^{22} at energies of 0 (0.31 millibarns), 1.3 (2.5 millibarns), 3.3 (0.6 millibarns), 4.4 (0.9 millibarns), 5.4 and 5.7 MeV (approximately 2 millibarns for both). This experiment establishes the existence of Ne^{22} levels at the three highest energies. Previous evidence for a level between 4 and 5 MeV is discussed and is found to be compatible with the present results. A.

539.17

1976. PHOTODISINTEGRATION OF THE DEUTERON AT ENERGIES FROM 50 TO 150 MeV.
Yu.A.Alexandrov, N.B.Delone, L.I.Slovokhotov, G.A.Sokol and L.N.Shtarkov.
Zh. éksper. teor. Fiz., Vol. 33, No. 3(9), 614-20 (1957). In Russian.

Photodisintegration of the deuteron was investigated using the 265 MeV synchrotron with D_2O and H_2O targets by recording the protons with a telescope of two proportional counters. The differential cross-sections were measured at angles of 22.5, 45, 67.5, 90, 112.5, 135, 157.5° and γ-quantum energies of 54, 70, 88, 110, 129 and 148 MeV in the laboratory system of coordinates. The obtained angular distributions are compared with the calculations of Marshall and Guth (Abstr. 8224/1950). A.

539.17 : 539.12

PAIR PRODUCTION BY HIGH-ENERGY PHOTONS. See Abstr. 1822

539.17

1977. FURTHER MEASUREMENTS ON n,p REACTIONS AT 14 MeV : Ti, Rh, Sn, Ta, Au AND ANGULAR DISTRIBUTION OF PROTONS EMITTED IN THE Ca(n,p) AND Ni(n,p) REACTIONS. L.Colli, U.Facchini, I.Iori, G.Marcazzan. A.Sona and M.Pignanelli.
Nuovo Cimento, Vol. 7, No. 3, 400-10 (Feb. 1, 1958).

Reports spectra of protons emitted by (n,p) reactions with 14 MeV energy neutrons on the medium weight and heavy elements Ti, Rh, Sn, Ta, Au. Angular distributions are also given for the two elements Ca, Ni. These spectra were obtained by improving the the technique already employed for lighter elements, making use of coincidence between scintillation and gas counters. A.

539.17

1978. PARITY CONSERVATION IN STRONG INTERACTIONS: THE $^{7}Be(n,\alpha)^{4}He$ REACTION.
R.E.Segel, J.V.Kane and D.H.Wilkinson.
Phil. Mag (Eighth Ser.), Vol. 3, 204-7 (Feb., 1958).

The spin of the Be^{7} nucleus is $^{3}/_{2}$ and the parity odd (Abstr. 7273/1955). Therefore the parity of the Be^{8} state formed by the absorption of a thermal neutron (in an S-state relative to the nucleus) must also be odd. Such a state cannot decay to two alpha-particles. The Q-value for the reaction is 18.98 MeV, consequently the observation of two 9.5 MeV alpha-particles in coincidence in this reaction would demonstrate parity non-conservation in nuclear interactions. This is sought and an upper limit of 25 millibarns can be set for the reaction, whence it is concluded that the degree of parity violation is $\overline{\mathcal{F}}^{2} \leq 1 \times 10^{-7}$. This result is independent of assumptions concerning the charge independence of nuclear forces, in contrast to earlier investigations on parity selection rules in nuclear reactions.
P.K.Kabir

539.17

1979. $P^{31}(n,p)Si^{31}$ AND $Al^{27}(n,\alpha)Na^{24}$ CROSS SECTIONS.
J.A.Grundl, R.L.Henkel and B.L.Perkins.
Phys. Rev., Vol. 109, No. 2, 425-8 (Jan. 15, 1958).

The excitation functions and absolute cross-sections for these reactions were measured by the activation method for neutron energies below 9.5 MeV and at 14.1 MeV. The excitation function for $P^{31}(n,p)Si^{31}$ rises from 1.6 MeV to 5.5 MeV, is fairly constant at 0.14 barn to 9.5 MeV and considerably lower at 14 MeV. The $Al^{27}(n,\alpha)Na^{24}$ excitation curve rises from 6 to 9 MeV neutron energy and is greater at 14 MeV. Comparisons are made with earlier measurements of the $P^{31}(n,p)Si^{31}$ cross-section and some discrepancies appear. A.

539.17

1980. NUCLEAR CROSS SECTIONS FOR 765 MeV NEUTRONS.
N.E.Booth, G.W.Hutchinson and B.Ledley.
Proc. Phys. Soc., Vol. 71, Pt 3, 293-304 (March, 1958).

Total cross-sections have been measured for the elements H, D, Li, C, O, Al, Cu, Sb and Pb and absorption cross-sections for C, Al, Cu and Pb for neutrons of an effective energy of 765 ± 30 MeV. The neutrons were detected by observing the Cherenkov light from charged secondaries produced in a cylinder of Perspex. Large corrections must be applied to the measured absorption cross-sections and these are strongly dependent upon the differential cross-section assumed. The results are compared with an optical model with a potential distribution indicated by electron scattering measurements, and with an imaginary central potential and a real spin–orbit potential. The results can be adequately represented by assuming that at this energy the imaginary potential is given by the free nucleon–nucleon total cross-sections and that the nuclear potential size and shape agree with the charge density size and shape. The spin–orbit coupling parameter required to fit the results is somewhat less than that found at lower energies. A.

539.17 : 539.166.2 : 539.14

1981. SOFT γ-RAYS EMITTED BY NUCLEI ON CAPTURE OF THERMAL NEUTRONS.
I.V.Éstulin, L.F.Kalinkin and A.S.Melioranskiĭ.
Zh. éksper. teor. Fiz., Vol. 32, No. 5, 979-92 (1957). In Russian.

A luminescent spectrometer was used to measure the energy and absolute intensities of gamma-rays emitted by Co^{59}, Rh^{103}, Sm^{148}, Au^{197} and Hg^{199} nuclei capturing thermal neutrons. It is shown that the detected γ-lines which lie in the 50-500 keV energy range can be ascribed to transitions from the lowest excited states of the investigated nuclei. A.

539.17

1982. SPALLATION AND HEAVY ION REACTIONS.
J.H.Fremlin.
Physica, Vol. 22, No. 11, 1091-102 (Nov., 1956).

"Amsterdam Nuclear Reactions Conference". The reactions discussed are those in which enough energy is available to liberate several heavy particles. No rigid separation between spallation and heavy-ion reactions is possible but it is convenient to make some distinction. The term spallation is here limited to those reactions emitting several particles in which the average kinetic energy of nucleons in the bombarding particle is many times the potential barrier of the target nucleus to a proton. So far such reactions have been obtained only with alpha-particles or lighter projectiles. The heavy-ion reactions considered are those in which this is not true although the total available energy, and the number of evaporated particles, may be comparable. Spallation reactions produced by deuterons and protons with energies near 100 MeV show a considerable loss of charged secondary particles from both medium and heavy elements, fission appearing as a competing process in the heaviest elements. In such reactions the sharing of energy among the total available nucleons may not be complete before heavy-particle emission. Heavy-ion reactions vary markedly in different ranges of atomic number. In light elements, fragmentation and "buckshot" reactions compete to an important extent with compound nucleus formation. In medium elements, compound nucleus formation followed by evaporation is the main process, the evaporation of neutrons becoming predominant as the atomic number rises. For the heaviest elements, fission is overwhelmingly the most important type of reaction. The competition between different kinds of reaction is discussed. A.

539.17 : 537.591.8

NUCLEAR DISINTEGRATIONS PRODUCED BY COSMIC RADIATION. See Abstr. 1763

539.17

1983. FISSION. J.A.Wheeler.
Physica, Vol. 22, No. 11, 1103-14 (Nov., 1956).

"Amsterdam Nuclear Reactions Conference". Of the many developments in the experimental and theoretical study of fission, special attention is given in this paper to (a) fission widths, (b) the channel analysis of fission and (c) fission asymmetry. The possibility is indicated of characteristic differences from one slow neutron resonance to another in the percentage abundance of symmetric fission. A.

539.17

1984. DELAYED NEUTRONS FROM 15.5 SEC Br^{88}.
G.J.Perlow and A.F.Stehney.
Phys. Rev., Vol. 107, No. 3, 776-80 (Aug. 1, 1957).

A description is given of a gas-flow system which permits quick chemical isolation of bromine fission fragments. By use of this system, Br^{88} was found to be a delayed-neutron precursor resulting from the fission of U^{235}. The half-life measured by neutron counting is 15.5 ± 0.4 sec, in agreement with that previously measured for Br^{88} by radiochemical techniques. It is a relatively abundant source of delayed neutrons, producing per fission 3.5 ± 1.5 times the number of neutrons in the 54 sec group having Br^{87} as a precursor. Br^{88} is the first definitely established case of a delayed-neutron precursor of odd proton and odd neutron number. Qualitative arguments are given to show that such nuclei are about as likely to be delayed-neutron precursors as are those of odd Z and even N, although only the latter have been reported previously. A.

539.17

1985. NUCLEAR FISSION INDUCED BY ACCELERATED NITROGEN IONS. V.A.Druin, S.M.Polikanov and G.N.Flerov.
Zh. éksper. teor. Fiz., Vol. 32, No. 6, 1298-1304 (1957). In Russian.

Experiments on fission of U^{235}, U^{238}, Bi, Au, Re and Yb induced by accelerated nitrogen ions are described. The measurements were made using an ionization chamber. The dependence of the fission cross-sections for these nuclei on the nitrogen ion energy was studied in the energy range from 70 to 110 MeV. The obtained results are analysed from the view-point of influence of the parameter Z^{2}/A and excitation energy on the probability of fission. A.

539.17

1986. FISSION OF URANIUM AND PROTOACTINIUM AT HIGH EXCITATION ENERGIES. V.P.Shamov.
Zh. éksper. teor. Fiz., Vol. 33, No. 2(8), 346-53 (1957). In Russian.

Fission of uranium and protactinium at initial excitation energies of 100 MeV is considered. The analysis is based on comparison of the yields of the uranium isotopes U^{230}–U^{232} and protoactinium isotopes Pa^{231}–Pa^{227} (equal values of the parameter Z^{2}/A) produced in the disintegration of uranium U^{238} by 340 MeV protons. The results of the analysis point to emission nature of uranium and protoactinium fission in the indicated range of initial excitation energy. A.

539.17

1987. FISSION OF Ra^{226} BY 11 MeV PROTONS.
R.C.Jensen and A.W.Fairhall.
Phys. Rev., Vol. 109, No. 3, 942-6 (Feb. 1, 1958).

The fission of Ra^{226} by 11 MeV protons was studied by using radiochemical techniques. The mass-yield curve of fission products shows three humps: a narrow hump centred about mass 112, corresponding to a symmetric fission mode, with two humps on either side, corresponding to an asymmetric fission mode. The measured fission yields of fission fragments at the peaks of all three humps

are about the same. The heavy-fragment "wing" of the asymmetric portion of the mass-yield curve is very similar in position and shape to the corresponding member of other asymmetric mass-yield curves. The light-fragment "wing" has accordingly shifted to lower mass numbers, continuing the trend observed in the asymmetric fission-yield curves of elements heavier than radium. The central, symmetric-fission hump is of the same width as the narrow, symmetric-fission curve observed for fission of bismuth by 20 MeV deuterons. The cross-section for fission of Ra^{226} by 11 MeV protons is measured to be $2 \pm 1 \times 10^{-27}$ cm^2, and drops by a factor of about 60 when the proton energy is degraded to 9 MeV. A.

539.17

1988. ON THE POSSIBLE EFFECTIVENESS OF MESONIC CATALYSIS OF NUCLEAR REACTIONS. Ya.B.Zel'dovich.
Zh. éksper. teor. Fiz., Vol. 33, No. 7, 310-11 (1957). In Russian.

The problem is outlined for reactions involving the fusion of protons with deuterons or tritons. The probability that the μ^--meson escapes after the reaction, and so remains effective for further catalysis, is estimated and the results considered.

G.H.Burkhardt

539.172

NUCLEAR REACTIONS DUE TO COSMIC RAYS. See also under "Cosmic rays". Decimal classification 537.591.8

ATOMS

539.18

1989. THE SELF-CONSISTENT FIELD WITH EXCHANGE FOR NEON BY FERUT PROGRAM. B.H.Worsley.
Canad. J. Phys., Vol. 36, No. 3, 280-99 (March, 1958).

A general programme for the computation of atomic self-consistent fields with exchange has been prepared for the University of Toronto electronic digital computer, FERUT. It was developed by application to neutral neon, for which the results are given, and tested against the independently calculated results for Fe^{+14} and Fe^{+16}. A.

539.18

1990. REPRESENTATION OF THE EXCHANGE TERMS IN FOCK'S EQUATIONS BY A QUASI-POTENTIAL. D.R.Hartree.
Phys. Rev., Vol. 109, No. 3, 840-1 (Feb. 1, 1958).

Fock's equations for the (nl) wave-function of an atom can be expressed in the form of Schrödinger's equation for a single particle by including in the potential energy a term $\eta(nl;r)$ expressing the "exchange" terms in the equation. As a further approximation, this term can be replaced by some average over the various (nl) wave-functions. This "exchange" contribution to the potential is evaluated for the (nl) wave-functions of Cu^+, and an appropriate mean is compared with the "averaged exchange potential", based on the statistical model, suggested by Slater and used by Pratt in calculations for Cu^+. It is found that the range of variation of $\eta(nl;r)$ with (nl) is of the order of a factor 2, so that its replacement by an average over (nl) is only a rough way of treating exchange effects. A.

539.18 : 535.331

1991. THE RELATIVE F-NUMBERS OF THE HEAD TERMS OF THE DIFFUSE AND SHARP SERIES OF Al I. Yu.I.Ostrovskiĭ.
Optika i Spektrosk., Vol. 2, No. 5, 673 (1957). In Russian.

The ratios of the oscillator strengths for four strong lines of Al I were measured by the method of "hooks" of D.S.Rozhdestvenskiĭ using apparatus described in Optika i Spektrosk., Vol. 1, 821, 1956. The ratios of the f-numbers for wavelengths 3944.03, 3961.53, 3082.15, 3092.75 A can be represented, within the experimental error, by a series of integers: 2:2:3:3. The results obtained for the ratio of the 3944 and 3961 lines agree well with earlier work.

S.Chomet

539.18

1992. NUMERICAL CALCULATION OF THE WAVE FUNCTIONS AND ENERGIES OF THE 1 ^{1}S AND 2 ^{3}S STATES OF HELIUM.
D.H.Tycko, L.H.Thomas and K.M.King.
Phys. Rev., Vol. 109, No. 2, 369-74 (Jan. 15, 1958).

An exact iteration method for obtaining solutions to the eigenvalue problems of quantum mechanics is used as the basis for developing a numerical iteration scheme for the approximate solution of such problems. The connection between an approximate analytic iteration method and the standard variational method is made and the former method is applied to the 1 ^{1}S state of He. The wave-functions so determined are linear combinations of products of hydrogen-like wave-functions. The best value of the energy obtained with twenty parameters is $E(1\ ^1S) = -2.900938$ a.u. By using the theory of Gaussian quadrature and least-squares approximation, a systematic transition from an exact iteration method to the numerical iteration method can be made. The resulting numerical scheme is applied to the 1 ^{1}S and 2 ^{3}S states of He. The energies obtained are $E(1\ ^1S) = -2.903443$ a.u. and $E(2\ ^3S) = -2.174823$ a.u. The 2 ^{3}S wave-function yields a He^3 hyperfine splitting $\nu = 6664$ Mc/s, which is lower than the experimental value by about 1%. The wave-functions obtained are expressible in both the coordinate and momentum representations. A.

539.18

1993. THE $(2s)^2\ ^1S$ STATE SOLUTION OF THE NON-RELATIVISTIC SCHRÖDINGER EQUATION FOR HELIUM AND THE NEGATIVE HYDROGEN ION. E.Holøien.
Proc. Phys. Soc., Vol. 71, Pt 3, 357-68 (March, 1958).

A finite set of possible Slater determinants with spatial part constructed from an orthonormal complete one-electron set of associated Laguerre functions in the radial coordinates, and Legendre functions in the angular coordinates, has been introduced into the minimal sequence of the Ritz variational principle applied to the $(2s)^2$ state solution (L = 0) of the two-electron wave equation for infinite nuclear mass. The sequence converges on a certain limiting eigenfunction of the energy state. The numerical solution of the function and the corresponding energy value are given for helium as well as the negative hydrogen ion. The identification of certain helium lines in the vacuum ultraviolet is discussed. A.

539.18

1994. HYPERFINE STRUCTURE MEASUREMENTS ON PLUTONIUM-239.
J.C.Hubbs, R.Marrus, W.A.Nierenberg and J.L.Worcester.
Phys. Rev., Vol. 109, No. 2, 390-8 (Jan. 15, 1958).

The atomic hyperfine structure was investigated by the atomic-beam magnetic resonance method. Research centred about a relatively highly populated electronic energy level having unit angular momentum which is probably the first excited state of a ground-state ^{7}F term arising from the configuration $(5f)^6\ (6d)^0\ (7s)^2$. Atomic and hyperfine structure constants for this level are found to be $I = \frac{1}{2}$, $J = 1$, $g_J = 1.4975 \pm 0.0010$, $\Delta\nu = 7.683 \pm 0.060$ Mc/s. From the measured hyperfine structure separation and 5f wave-functions derived from a Hartree relativistic calculation, the nuclear magnetic moment is inferred to be ± 0.02 n.m. under the assumption that the J = 1 level under investigation arises from a pure ^{7}F term belonging to the configuration $(5f)^6$. A.

539.18

1995. THE K AUGER SPECTRUM.
W.N.Asaad and E.H.S.Burhop.
Proc. Phys. Soc., Vol. 71, Pt 3, 369-82 (March, 1958).

The fine structure of the K Auger spectrum is discussed and the positions and intensities of the K—LL and K—LM Auger lines calculated for different values of Z using a non-relativistic theory and assuming intermediate coupling between the two inner shell vacancies of the atom in the final states. In regions of intermediate atomic number the usual six-line K—LL spectrum expected on the basis of the j—j coupling is modified into a nine-line spectrum and the relative intensity of the various lines varies markedly with Z. The effect of inter-configuration terms on the K—LL spectrum is a also discussed. The observed position and relative intensities of the K—LL lines can be understood when reasonable allowance is made for relativistic effects but the interpretation of the rather meagre experimental data on the K—LM spectrum is less clear, although there is qualitative agreement with the theoretical predictions. A.

539.18

1996. A METHOD OF DETERMINING ISOTOPIC COMPOSITION OF URANIUM SAMPLES. J.Derham and F.W.Fenning.
Atomic Energy Res. Establ. (Harwell) Rep. R/R834, 6 pp. (1957).

The method is based on a comparison of the β-activity of a known amount of the sample with the β-activity of a similar sample of natural uranium. The accuracy quoted for the 235 and 238 isotopes in the sample measured is $\pm 0.4\%$ by weight. H.C.Cole

539.18

1997. FRACTIONATION OF OXYGEN ISOTOPES IN THE FORMATION OF OXIDE FILMS ON COPPER.
J.B.Brown, M.Dole and G.A.Lane.
J. chem. Phys., Vol. 27, No. 1, 251-8 (July, 1957).

The fractionation of the oxygen isotopes in the formation of oxide films on copper was measured at 0, 25, and 100°C on granular copper and copper foil by determining the O^{18}/O^{16} isotope ratio in the

residual unreacted oxygen gas after a fraction of the oxygen had reacted. An analysis is given of the mixing problem and of the kinetics of the reaction. Two fractionation factors, one of unity or less than unity for an initial rapid reaction and one greater than unity for the slower and (approximately) steady state reaction are required to explain the data. The fractionation factor for the steady state reaction is calculated to be 1.045, 1.042, and 1.037 at 0, 25, and 100°C, respectively. All of these values are greater than the lower limit of 1.029 given by the rate theory of Bigeleisen in contrast to an earlier conclusion of Bernstein. A.

539.18

1998. SEPARATION OF HELIUM ISOTOPES BY DISTILLATION AND THERMO-OSMOSIS. V.M.Kuznetsov.
Zh. éksper. teor. Fiz., Vol. 32, No. 5, 1001-11 (1957). In Russian.

The main characteristics of a packed distillation column for separation of a He^3–He^4 mixture and of a filter for enrichment of the solution with the light helium isotope by means of the thermomechanical effect have been determined experimentally. The results are compared with theory. A brief description of a double-beam mass-spectrometric gas analyser for continuous working is given. A.

539.18 : 536.423.1

1999. VARIATION OF THE ISOTOPIC COMPOSITION OF MERCURY ON EVAPORATION.
V.N.Grigor'ev, Ya.S.Kan, N.S.Rudenko and B.G.Safronov.
Zh. éksper. teor. Fiz., Vol. 33, No. 3(9), 576-80 (1957). In Russian.

Changes in the isotopic composition of mercury when evaporated under various conditions were investigated. A significant influence of the kinetics of evaporation has been detected at small sublimation rates. The upper limits of $\Delta p/p$ for mercury isotopes have been determined. A.

539.18 : 537.39

2000. VARIATION OF THE ISOTOPIC COMPOSITION OF MERCURY IN D.C. ELECTRIC FIELD. I.V.Bogoyavlenskiĭ, V.N.Grigor'ev, N.S.Rudenko and D.G.Dolgopolov.
Zh. éksper. teor. Fiz., Vol. 33, No. 3(9), 581-7 (1957). In Russian.

Dependence of the isotopic composition of liquid mercury on the time, during which a d.c. electric current was passed through it, was determined at two temperatures. Distribution of the isotopic concentration along the electric field and dependence of the variation of the isotopic composition at the cathode on the applied voltage are investigated. The experimental results are compared with phenomenological calculations and possible causes of the effect are discussed. A.

539.18 : 535.33.03

A NEW METHOD OF SPECTRUM EXCITATION IN AN ATOMIC BEAM. See Abstr. 1593

539.18

2001. LOW-ENERGY INELASTIC ATOMIC COLLISIONS. P.Rosen.
Phys. Rev., Vol. 109, No. 2, 348-50 (Jan. 15, 1958).

An approximation method is described which is useful for finding inelastic collision cross-sections for atomic collisions at energies above about 1 eV near threshold. The method uses classical paths for the atoms and the distance of closest approach which is determined from known interatomic forces. The method is applied to the problem of finding the ionization cross-section of helium–helium collisions. The comparison of theory and experiment shows satisfactory results. A.

539.18

2002. IONIZATION CROSS SECTION OF ARGON–ARGON COLLISIONS NEAR THRESHOLD. P.Rosen.
Phys. Rev., Vol. 109, No. 2, 351-5 (Jan. 15, 1958).

The ionization cross-section of argon–argon collisions near threshold is calculated by using a semiclassical method (see preceding abstract). The wave-function of the eight electrons in the M shell is obtained approximately by considering the core as having an atomic number of eight. Products of hydrogenic functions are used for the eight M electrons, with the screening constants of Slater. The agreement between theory and experiment is satisfactory. A.

539.18

2003. CALCULATION OF THE INTERACTION POTENTIAL OF ATOMS. O.B.Firsov.
Zh. éksper. teor. Fiz., Vol. 33, No. 3(9), 696-9 (1957). In Russian.

The sum of Coulomb interaction between atomic nuclei and the change in electron energy connected with decrease of the distance between the nuclei is chosen as the interaction potential. The electron energy is computed on basis of the statistical model. A.

539.18 : 537.564

ON THE INTERACTION BETWEEN LITHIUM IONS AND MATTER. See Abstr. 1744

MOLECULES

539.19

2004. VIBRATIONAL MATRIX ELEMENTS OF NO.
R.G.Breene, Jr and M.N.Todd, Jr.
J. chem. Phys., Vol. 28, No. 1, 11-15 (Jan., 1958).

A potential function meeting certain qualitative criteria is developed from the Lippencott potential, a seven-term expansion of this function being actually utilized. A three-term expansion of the dipole moment is used within the framework of familiar perturbation theory to obtain the vibrational-matrix elements for the fundamental and first four overtone transitions arising from each of the first eleven levels. The results of this calculation are utilized for a further investigation of the potential function, and the approximations involved are considered. This calculation was programmed and carried out on the I.B.M. 650 electronic data processing machine, and is readily adaptable to other diatomic molecules for which the requisite empirical data are available. A.

539.19

2005. VIBRONIC STATES OF OCTAHEDRAL COMPLEXES.
W.Moffitt and W.Thorson.
Phys. Rev., Vol. 108, No. 5, 1251-5 (Dec. 1, 1957).

The interactions which occur between nuclear and electronic motions in electronically degenerate states of octahedral molecules are investigated. A.

539.19

2006. TEMPERATURE DEPENDENCE OF VIBRATIONAL RELAXATION TIMES IN GASES.
P.G.Corran, J.D.Lambert, R.Salter and B.Warburton.
Proc. Roy. Soc. A, Vol. 244, No. 1237, 212-19 (1958).

Ultrasonic dispersion measurements at varying temperatures, extending over the range 290 to 580°K, have been made on gaseous ethylene, cyclopropane, carbon tetrafluoride, methyl chloride and methyl bromide. The results are correlated with previous measurements on methyl fluoride and sulphur dioxide. The non-polar gases show a steady rise in the probability of energy transfer between translation and vibration with rise in temperature. The transition probability, P_{10}, is found to vary with $\exp(-T^{-1/3})$ in accordance with current collision theory, but the quantitative dependence cannot be predicted from molecular properties. The polar gases behave in a similar way at higher temperatures, but at lower temperatures the transition probability increases with falling temperatures. This is interpreted as due to increasing predominance of oriented collisions, which are specially favourable for energy transfer, between polar molecules at lower temperatures. A.

539.19 : 535.333

CS_2^+ ROTATIONAL STRUCTURE AND BOND DISTANCES. See Abstr. 1601

539.19 : 535.333

ROTATIONAL ANALYSIS OF SiF. See Abstr. 1603

539.19 : 535.343

2007. ELECTRONIC SPECTRAL SHIFTS OF NONPOLAR MOLECULES IN NONPOLAR SOLVENTS.
H.C.Longuet-Higgins and J.A.Pople.
J. chem. Phys., Vol. 27, No. 1, 192-4 (July, 1957).

A theory of the red-shift of low-lying electronic bands of nonpolar molecules in nonpolar solvents is presented. The difference between the dispersion forces in the ground and excited states is investigated by perturbation theory and an approximate formula is derived according to which (in dilute solution) Red shift = $\frac{1}{6}\alpha_B z\bar{R}^{-6}\{\frac{1}{4}E\alpha_A + M^2\}$, where α_A and α_B are the molecular polarizabilities of the solute and solvent, respectively, M and E are the dipole moment and energy of the transition, and each solute molecule is supposed to be surrounded by z solvent molecules at a mean distance $\bar{R}$. A.

539.19

2008. THEORY OF NUCLEAR MAGNETIC SHIELDING IN MOLECULES. I. LONG-RANGE DIPOLAR SHIELDING OF PROTONS. H.M.McConnell.
J. chem. Phys., Vol. 27, No. 1, 226-9 (July, 1957).

The general nuclear magnetic shielding theory of Ramsey (Abstr. 7421/1950, 5193/1952) is developed for the case of "long-range" nuclear shieldings. Such shieldings arise from the magnetization induced in molecular electrons localized to groups one or more bond lengths removed from the shielded nucleus. Order-of-magnitude calculations indicate that these long-range shielding fields can make significant contributions to proton chemical shifts in, for example, aromatic hydrocarbons and alkyl halides. A.

539.19

2009. NUCLEAR QUADRUPOLE COUPLING IN THE Li_2 MOLECULE. I.Mannari and T.Arai.
J. chem. Phys., Vol. 28, No. 1, 28-31 (Jan., 1958).

The method of deformed atoms in molecules is applied to calculate the electric field gradient q at a nucleus in Li_2, using the molecular wave-function obtained by Arai and Sakamoto. The field gradient is composed of nuclear and electronic terms which almost cancel each other, so that its magnitude and even its sign are seriously affected by accuracy of wave-functions used. It is nevertheless expected that the A.S. wave-function, which gives a dissociation energy of 0.96 eV compared with the experimental value of 1.05 eV, is sufficiently accurate. Neglecting the shielding effect induced in the 1s shell by the nuclear quadrupole moment Q, the result obtained is $q/2e = q' = -0.0034$ a.u. at an internuclear distance of 4.93 a.u. The nuclear quadrupole coupling constant eqQ found experimentally is positive (+0.060 Mc/s). A negative value of the quadrupole moment $Q(Li^7)$ thus is obtained, in agreement with the prediction of the nuclear shell model. A.

539.19

2010. EXCHANGE BROADENING IN NUCLEAR MAGNETIC RESONANCE. J.Kaplan.
J. chem. Phys., Vol. 28, No. 2, 278-82 (Feb., 1958).

A general theory of the nonsaturated n.m.r. spectra of chemically exchanging molecules is formulated. As an example the case of a molecule with two nonequivalent protons exchanging with a molecule with one proton is worked out in detail. Connection is made with previous theories by taking limiting expressions of the general results. In the appendix it is shown how the method can be extended to include saturation and hindered rotation. A.

539.19

2011. RELAXATION EFFECTS FOR COUPLED NUCLEAR SPINS. R.C.Rempel.
Phys. Rev., Vol. 109, No. 3, 831-9 (Feb. 1, 1958).

Nuclear relaxation effects in molecules containing several coupled spins are treated by a generalization of the method of Wangsness and Bloch. Variations in line shape and structure for two coupled spin-$\frac{1}{2}$ nuclei as various parameters are changed from one extreme to another are derived and plotted graphically. The calculation is continued to obtain an expression for the line shapes in the double-resonance experiment of Bloom and Shoolery. It is next shown that under certain circumstances the concept of "semi-macroscopic magnetic moments" enables one to write the quantum-mechanical equations of motion in the form of coupled Bloch phenomological equations. In addition, a discussion of internal relaxation and the Overhauser effect is given. A.

539.19 : 530.145

2012. ON THE USE OF THE BORN—OPPENHEIMER APPROXIMATION IN MOLECULAR PROBLEMS. A.D.Liehr.
Ann. Phys. (New York), Vol. 1, No. 3, 221-32 (June, 1957).

The original Born—Oppenheimer method for solving the complete molecular Schrödinger equation must be modified if approximate electronic wave-functions are employed. In this paper a reformulation of the original Born—Oppenheimer calculation which incorporates such modifications is given. A short discussion of the application of the derived formulae to computations of the intensities of "forbidden" electronic transitions and the stabilities of specific nuclear configurations is also presented. A.

539.19 : 535.343

2013. ULTRAVIOLET SPECTRA AND ELECTRONIC STRUCTURE OF METALLIC COMPLEXES. I. CHLOROAMMINE COBALT (III) COMPLEXES.
K.Nakamoto, J.Fujita, M.Kobayashi and R.Tsuchida.
J. chem. Phys., Vol. 27, No. 2, 439-44 (Aug., 1957).

In order to study the nature of the so-called "first, second, third, and specific bands" of the metallic complexes, the semiempirical M.O. method is applied to a series of $[Co(NH_3)_{6-n}Cl_n]^{(3-n)+}$ (n = 0, 1, 2 cis,trans) type complexes taking π electrons of the ligands into consideration. The agreement between the calculated and observed energies of transition is satisfactory partly due to the appropriate values of the parameters used. The following conclusions are obtained by the calculation: (1) The magnitude of the splitting of the first band depends upon the overlap integral, $S(3d\pi, np\pi)$ and also the ionization potential of the ligand (π). (2) The splitting of the first band in the cis-complex is small compared to that of the trans-complex, since, in the former, the three orbitals, from which electrons are excited to produce the low-energy absorptions, lie at nearly the same energy. (3) Two strong bands in the ultraviolet region are due to the transitions approximately from the ligand level to the metal level, and therefore, correspond to the so-called "third bands". They will show "blue-shift" in polar media. (4) The general rule that the trans-complex shows the third bands at longer wavelength than that of the cis-complex can be accounted for more satisfactorily if the Cl—Cl interaction in the cis-complex is considered. (5) The spectra of other halogenoammine complexes are reasonably interpreted in a similar manner. A.

539.19

2014. PI COMPLEXES BETWEEN ORGANIC FREE RADICALS. K.H.Hausser and J.N.Murrell.
J. chem. Phys., Vol. 27, No. 2, 500-4 (Aug., 1957).

The spectroscopic and magnetic properties of N-ethylphenazyl and Wurster's blue perchlorate show characteristic changes at low temperature. Using Mulliken's charge-transfer theory, it is shown that the formation of π complexes can account for these changes. The intense long wavelength absorption band which appears at low temperatures in both cases, is attributed to a transition to a state which is an antisymmetrical combination of two charge-transfer configurations, in which all the electrons are paired. The properties of these π complexes are compared with the properties of the biradicals related to 4,4'-bis-diphenylmethylenediphenyl (chichibabin hydrocarbon). A.

539.19

2015. CALCULATION OF ATOMIC VALENCE STATE ENERGIES. A.L.Companion and F.O.Ellison.
J. chem. Phys., Vol. 28, No. 1, 1-8 (Jan., 1958).

Given a molecular valence-bond wave-function (constructed according to the approximation of perfect pairing), the general theory is presented for calculating either (1) the energy following complete nonadiabatic dissociation of the atoms (hence, the promotional energy) or (2) the intra-atomic energy of the molecule for equilibrium positions of the nuclei. It is found that existent methods and tables are generally sufficient for treating only molecules having less than two unpaired electrons and, if hybridization is admitted, only molecules having less than two bonds. Tables are given which serve the needs with respect to all possible structures involving s- and p-valence electrons. Promotional energies for the CH and CH_2 molecules are derived for illustration. A.

539.19

2016. THEORY OF ISOTROPIC HYPERFINE INTERACTIONS IN π-ELECTRON RADICALS. H.M.McConnell and D.B.Chesnut.
J. chem. Phys., Vol. 28, No. 1, 107-17 (Jan., 1958).

Indirect proton hyperfine interactions in π-electron radicals are first discussed in terms of a hypothetical CH fragment which holds one unpaired π electron and two σ-CH bonding electrons. Molecular orbital theory and valence bond theory yield almost identical results for the unpaired electron density at the proton due to exchange coupling between the π electron and the σ electrons. The unrestricted Hartree—Fock approximation leads to qualitatively similar results. The unpaired electron spin density at the proton tends to be antiparallel to the average spin of the π electron, and this leads to a negative proton hyperfine coupling constant. The theory of indirect proton hyperfine interaction in the CH fragment is generalized to the case of polyatomic π-electron radical systems; e.g., large planar aromatic radicals. In making this generalization there is introduced an unpaired π-electron spin density operator ρ_N, where N refers to carbon atom N. Expectation values of the spin density operator ρ_N are called "spin densities", ρ_N, and can be positive or negative. In the simple one electron molecular orbital approximation a π-electron radical always has a positive or zero spin density at carbon atom N, $0 \leq \rho_N \leq 1$. In certain π-electron radical systems; e.g., odd-alternate hydrocarbon radicals, the spin densities at certain (unstarred) carbon atoms are negative when the effects of π—π configuration interaction are included in the π-electron wave-function. The previously proposed linear relation between the hyperfine splitting due

to proton N, a_N, and the unpaired spin density on carbon atom N, ρ_N,

$$a_N = Q\rho_N$$

is derived under very general conditions. Two basic approximations are necessary in the derivation of this linear relation. First, it is necessary that $\sigma-\pi$ exchange interaction can be treated as a first order perturbation in π-electron systems. Second, it is necessary that the energy of the triplet antibonding state of the C—H bond be much larger than the excitation energies of certain doublet and quartet states of the π electrons. This derivation of the above linear relation makes no restrictive assumptions regarding the degree of $\pi-\pi$ or $\sigma-\sigma$ configuration interaction. The validity of the above approximations is discussed and illustrated by highly simplified calculations of the proton hyperfine splittings in the allyl radical, assuming the $\pi-\pi$ configuration interaction — and hence the negative spin density on the central carbon atom — to be small. Isotropic hyperfine interactions in molecules in liquid solution can also arise from spin—orbital interaction effects, and it is shown that these effects are negligible for proton hyperfine interactions in aromatic radicals. A.

539.19

2017. A ONE-CENTER WAVE FUNCTION FOR THE HYDROGEN MOLECULE. H.W.Joy and R.G.Parr.
J. chem. Phys., Vol. 28, No. 3, 448-53 (March, 1958).

Slater atomic orbitals, s, p, d, etc., centred at the molecular midpoint and having variable orbital exponents and variable principal quantum numbers, are used to construct a seven-term wave-function for the ground state of the hydrogen molecule of the form

$$\Psi = C_1(ss^{I}) + C_2(s^{II}s^{III}) + C_3(s^{IV}d_0) + C_4(s^{V}g_0) + \\ + C_5(p_0p_0) + C_6(p_{+1}p_{-1}) + C_7(p_0{}'f_0).$$

Values for the seven linear coefficients, the twelve orbital exponents and the twelve principal quantum numbers are determined by the variational method. The total molecular energy obtained is −1.15883 a.u., or 31.53 eV (exptl. 31.96 eV), corresponding to a binding energy of 4.32 eV (exptl. 4.75 eV). A ten-term function of similar form is constructed which gives a binding energy of 4.34 eV. A.

539.19

2018. NORMAL COORDINATES IN THE METHYL HALIDES. W.T.King, I.M.Mills and B.Crawford, Jr.
J. chem. Phys., Vol. 27, No. 2, 455-7 (Aug., 1957).

The potential-energy functions found by Chang for the methyl halides are put into valence-type form and revised to eliminate inconsistencies and to accord with the true (nontetrahedral) geometry and the normal frequencies (corrected for Fermi resonance and anharmonicity). The resulting valence-type force constants and normal coordinates are given for light (CH_3) and heavy (CD_3) chlorides, bromides, and iodides. A.

539.19

2019. MOLECULAR STRUCTURE AND INTERNAL ROTATION OF HEXACHLOROETHANE, HEXACHLORODISILANE, AND TRICHLOROMETHYL-TRICHLOROSILANE. Y.Morino and E.Hirota.
J. chem. Phys., Vol. 28, No. 2, 185-97 (Feb., 1958).

The molecular structure and internal rotation of C_2Cl_6, $SiCCl_6$, and Si_2Cl_6 molecules were investigated by means of the sector-microphotometer method of electron diffraction. An unmodified radial distribution function is proposed together with a reliability factor for the analysis of intensity curves obtained by the sector method. Two methods were used for estimating the height of potential barrier; one, which is applicable in case of high potential barrier, is to compute the height from the observed mean square amplitude of the gauche chlorine pair, the contribution of the skeleton vibrations being evaluated by a calculation based upon the force field compatible with the observed normal frequencies. The other method, which is available in case of low barrier, is to calculate the scattering intensity of a model having a certain potential barrier by taking a weighted average over-all values of internal angle. For $SiCCl_6$ both approximate methods resulted in almost the same value for the barrier height. The heights of the potential barrier obtained were 10.8, 4.3, and 1 kcal/mole for C_6Cl_6, $SiCCl_6$, and Si_2Sl_6, respectively. A.

539.19 : 539.12

SCATTERING OF NEUTRONS BY T_2, HT AND DT MOLECULES. See Abstr. 1850

539.19 : 538.569

2020. RADIATION EMITTED BY MOLECULES IN THE PRESENCE OF A STRONG HIGH-FREQUENCY FIELD. V.M.Faĭn.
Zh. éksper. teor. Fiz., Vol. 33, No. 2(8), 416-24 (1957). In Russian.

An electromagnetic field of frequency ω and amplitude F induces radiation of lower frequency Ω_0 in a molecular gas. The intensity of this radiation is computed. Quantum-electrodynamical considerations are presented which confirm the applicability of the correspondence principle to this phenomenon. A.

SOLID-STATE PHYSICS

539.2

2021. SURFACE STATES IN CRYSTALS. B.A.Lippmann.
Ann. Phys. (New York), Vol. 2, No. 1, 16-27 (July, 1957).

Two topics in the theory of one-dimensional crystals are considered. (1) Shockley states. These levels are ordinarily regarded as essentially different from states due to surface imperfections, for surface states of the Shockley type are possible, even in perfect crystals, provided the energy bands have crossed. It is noticed, however, that the analysis of Shockley levels and of levels originating from surface imperfections may be unified if the energy bands are ordered in a certain way. When the proper ordering of the energy bands is imposed, the unit cell shifts as a result of a band crossing, and an extra half-cell is left at each end of the crystal. These half-cells constitute "impurity layers", and give rise to surface levels according to the usual theory. (2) When are energy band crossings possible?. For a square well, it is known that the energy must be greater then the potential ($E > V$) everywhere in the unit cell. It is shown that a similar result holds for more general potentials: if the potential is real and (for convenience) symmetric, then if E is not $> V$ everywhere in the unit cell, there are no band crossings, and hence no Shockley levels. This last result is based on the general behaviour of the Bloch functions under time and space inversion, which is discussed in detail in an appendix. A.

539.2 : 535.343

LATTICE MECHANICS AND INFRARED SPECTRUM OF DIAMOND. See Abstr. 1610

539.2

2022. CHEMICAL POTENTIALS, SPIN TEMPERATURES, AND THE OVERHAUSER EFFECT. E.A.Desloge and W.A.Barker.
Phys. Rev., Vol. 108, No. 4, 924-7 (Nov. 15, 1957).

If a system of particles with spin is divided into groups according to spin state, a chemical potential can be assigned to each group. Spin distributions can then be described in terms of these chemical potentials and spin interactions can be treated as chemical reactions. In this manner the difficulties associated with spintemperatures can be avoided. A simple derivation of the Overhauser effect is possible. A.

539.2

2023. CELLULAR EIGENVALUES FOR TITANIUM METAL. S.L.Altmann and N.V.Cohan.
Proc. Phys. Soc., Vol. 71, Pt 3, 383-8 (March, 1958).

A programme developed by Altmann for a high-speed computer to carry out cellular computations for close-packed hexagonal metals has been applied to titanium. The eigenvalues and eigenfunctions corresponding to all states for $k = 0$ have been determined and the effect on these results of the type of potential field used has been investigated. A.

539.2 : 538.632

2024. HALL EFFECT IN Ni_3Mn AND Fe—Co AS A FUNCTION OF ORDER. S.Foner, F.E.Allison and E.M.Pugh.
Phys. Rev., Vol. 109, No. 4, 1129-33 (Feb. 15, 1958).

Room temperature Hall data were obtained for Ni_3Mn and Fe—Co samples that had been heat treated to produce varying amounts of atomic ordering. In Ni_3Mn the values of R_0* were found to change uniformly from a negative value for the well-ordered sample to a positive value for the disordered sample. In Fe—Co the values of R_0* were found insensitive to the degree of atomic ordering. Since room temperature is well below the Curie point for Fe—Co, the values of R_0* will be nearly identical to the ordinary Hall coefficients and therefore related to the band structure. In Ni_3Mn the magnetic properties — saturation inductance and Curie point — depend strongly upon the degree of atomic ordering. For disordered Ni_3Mn

the Curie point is very near room temperature. It was therefore believed that the dependence of R_0* upon the degree of atomic ordering was associated with a Curie point anomaly rather than a fundamental change in band structure. This hypothesis has been substantiated by preliminary measurements at 77°K ($T \ll T_c$). At these low temperatures R_0* does become negative in disordered Ni_3Mn. A.

539.2

2025. ELECTRON INTERACTION IN SOLIDS. GENERAL FORMULATION. P.Nozières and D.Pines.
Phys. Rev., Vol. 109, No. 3, 741-61 (Feb. 1, 1958).

A general Hamiltonian formalism is developed to treat from first principles the motion of electrons in solids, including their mutual Coulomb interaction. By a series of canonical transformations it is shown that under suitable circumstances (which obtain in nearly all solids) plasmons (a quantized collective plasma oscillation of the electron gas) represent a well-defined elementary excitation of the solid. The "existence criterion" for plasmons is found to be a high electronic polarizability. Where plasmons exist a satisfactory description of their properties can be given when the majority of the individual electron oscillator strengths correspond to transitions in which the energy change is large or small with respect to the plasmon energy, $\hbar\omega_p = \hbar(4\pi Ne^2/m)^{1/2}$. After the plasmon modes are separated out, the remaining electron interaction is found to be screened, with a range of the order of the interelectronic spacing. The usefulness of this effective Hamiltonian for the calculation of the electronic energy levels and cohesive energy in solids is discussed briefly. A.

539.2 : 537.226.1

2026. ELECTRON INTERACTION IN SOLIDS. COLLECTIVE APPROACH TO THE DIELECTRIC CONSTANT.
P.Nozières and D.Pines.
Phys. Rev., Vol. 109. No. 3, 762-77 (Feb. 1, 1958).

A quantum theory of the dielectric constant for solids of both low and high polarizability is developed from first principles. In the latter case, the approach used is collective in that the long-range part of the electron interaction is described by the plasmon field. The conditions under which the local field corrections of Lorentz may be neglected are clearly defined. Both the static and frequency-dependent dielectric constant are derived. It is shown that the interaction between electrons may be described in terms of the dielectric constant of the solid provided the electrons in question form a small minority group which can be isolated from the much larger majority electron group. The theory is applied to a calculation of the frequency-dependent longitudinal conductivity and the optical properties of the solid. A.

539.2

2027. ELECTRON INTERACTION IN SOLIDS. THE NATURE OF THE ELEMENTARY EXCITATIONS. P.Nozières and D.Pines.
Phys. Rev., Vol. 109, No. 4, 1062-74 (Feb. 15, 1958).

Possible elementary excitations in solids are studied with the aid of the general theoretical approach developed in preceding papers of this series. Particular attention is paid to the basic theoretical justification for the individual-particle-like elementary ("effective" electrons). It is concluded that good qualitative arguments may now be given for the existence of effective electrons in solids, but that a detailed quantitative deduction has yet to be made. The presence of an energy gap is shown to be a necessary condition for the existence of strong spatial correlations between minority carriers in solids (excitons, conduction electron plasmons in semiconductors, etc.) and the nature of such correlated minority electron excitations is discussed. The plasmon spectrum of various solids is discussed and compared with experiment. A.

539.2

2028. ELECTRONIC ENERGY BANDS IN ZnS: PRELIMINARY RESULTS. C.Shakin and J.Birman.
Phys. Rev., Vol. 109, No. 3, 818-19 (Feb. 1, 1958).

Preliminary results of the cellular calculations of electronic energy bands in cubic ZnS have been obtained at three points in the Brillouin zone: Γ, X, Λ. These results indicate that there is a normal order of states in the valence band, and an energy gap of 6-8 volts at $k = (0,0,0)$ corresponding to the $\Gamma_4' \rightarrow \Gamma_1$ transition. A.

539.2 : 538.27

2029. ELECTRON IN A PERIODIC ELECTRIC AND A UNIFORM MAGNETIC FIELD. II. G.E.Zil'berman.
Zh. éksper. teor. Fiz., Vol. 33, No. 2(8), 387-96 (1957). In Russian.

For Pt I, see Abstr. 6704 (1957). The energy spectrum of an electron in a crystal in a magnetic field is considered in the case when its trajectory in k-space (i.e. the intersection of the Fermi surface by a plane perpendicular to the magnetic field) is open periodic. In this case equidistant or quasi-equidistant discontinuities appear in the continuous spectrum. The distance between them is of the same order as that between the levels in a discrete spectrum ($\sim\epsilon^2$, where ϵ is a "reduced" lattice constant) and the width is, exponentially small or the order of ϵ^4; in particular cases it may be of the order of ϵ^3 or ϵ^2. The obtained results are applied to the theory of the de-Haas–van Alphen effect. A.

539.2

2030. A QUANTUM KINETIC EQUATION FOR ELECTRONS IN A METAL. R.N.Gurzhi.
Zh. éksper. teor. Fiz., Vol. 33, No. 2(8), 451-8 (1957). In Russian.

A quantum kinetic equation for electrons in a metal in an electromagnetic field was derived. In distinction to the usual equation the present one is not based on the assumption of smallness of the photon energy compared with kT. A.

539.2 : 530.162

2031. ON THE THEORY OF A DEGENERATE ELECTRON LIQUID. V.P.Silin.
Zh. éksper. teor. Fiz., Vol. 33, No. 2(8), 495-500 (1957). In Russian.

Landau's theory of a Fermi liquid (Abstr. 8604/1956) is extended to the case of an electron liquid and applied to metals. A.

539.2 : 539.12

ELECTRON ENERGIES IN SOLIDS DETERMINED FROM ANGULAR DISTRIBUTION OF POSITRON ANNIHILATION RADIATION. See Abstr. 1838

539.2

2032. ON THE THEORY OF INTERACTION BETWEEN "SUPERFLUOUS" CHARGES IN IONIC CRYSTALS.
V.L.Vinetskiĭ and M.Sh.Giterman.
Zh. éksper. teor. Fiz., Vol. 33, No. 3(9), 730-4 (1957). In Russian.

The interaction between polarons is considered. It is shown that in some crystals it is energetically preferable for "bipolarons" to be formed, that is two polarons which are located at a finite distance from each other and are connected by common polarization. A.

539.2

2033. DISLOCATION PATTERNS IN POTASSIUM CHLORIDE.
S.Amelinckx.
Acta metallurgica, Vol. 6, No. 1, 34-58 (Jan., 1958).

Dislocation patterns observed in "single crystals" of potassium chloride, as grown, and after deformation, are analysed. Large areas covered by regular square and hexagonal networks are found. Singularities in the networks are explained in terms of Burgers vectors and the genesis of the nets is considered. In particular evidence is presented for the stability of a[100] dislocation with respect to dissociation into two a/2[110] dislocations. It is found that a small driving force coming either from a third crossing dislocation, or from purely geometrical circumstances, and which tends to bring the two combining a/2[110] dislocations into a parallel position, is sufficient for the formation of a segment of a[100] dislocation. Evidence for the formation of "holes" at the intersection point of two singular dislocations with the same Burgers vector is also presented. It is suggested that networks are sometimes decorated more than once. A systematic use of this phenomenon might be of some value in studying the evolution of networks during anneal. Dislocations which moved during the anneal accompanying the decoration leave traces of particles behind them, suggesting that certain parts of the dislocation line are more effective in causing precipitation. The density of the decorating particles depends on the orientation of the line with respect to the Burgers vector; screws seem to be less easily decorated than edges. A.

539.2 : 539.27

2034. THE THEORY OF SMALL ANGLE SCATTERING FROM DISLOCATIONS. H.H.Atkinson and P.B.Hirsch.
Phil. Mag. (Eighth Ser.), Vol. 3, 213-28 (March, 1958).

The small-angle scattering of X-rays or neutrons from crystals containing a random network of dislocations is calculated. Three causes of density changes associated with dislocations are considered: that due to the elastic strain field from edge dislocations, that due to second-order elasticity effects and that due to the dislocation cores. It is found that in the range of angles for which experimental evidence is available, the effect due to the elastic strain field from edge dislocations predominates. The magnitude of the

scattering expected from the theory for a dislocation density of about 10^{11} cm^{-2} is of the same order as that found recently from small-angle neutron scattering experiments on heavily cold-worked copper. A.

539.2 : 535.377

2035. THERMAL BLEACHING OF F CENTERS AND ITS CORRELATION TO THERMOLUMINESCENCE IN X-RAY COLORED KCl CRYSTALS. A.A.Braner and A.Halperin.
Phys. Rev., Vol. 108, No. 4, 932-6 (Nov. 15, 1957).

A double-Dewar vacuum system, with an effective liquid-air trap close to the crystal inside it, is described. Undisturbed thermal-bleaching curves obtained with this system do not show any restoration of F-centres when one warms KCl crystals X-irradiated at liquid-air temperature. The thermal-bleaching curves obtained show steep fall-offs at certain temperatures throughout the examined temperature range of 90-600°K. The temperatures of fall-off in the bleaching curve fit well those of the peaks in the thermoluminescence curves obtained for the same crystal. This implies that F electrons are involved in practically all the luminescence peaks appearing in the glow curves of KCl crystals. A.

539.2

2036. THEORY OF PARAMAGNETIC RESONANCE OF F-CENTRES IN IONIC CRYSTALS. M.F.Deĭgen.
Zh. éksper. teor. Fiz., Vol. 33, No. 3(9), 773-9 (1957). In Russian.

A theory is developed for the hyperfine interaction of a localized electron with nuclear magnetic moments displaced by a certain distance from the centre of symmetry of the electron wave-function. The hyperfine structure of the electron energy levels is derived. The calculation is performed with the aid of "smoothed" and detailed F-centre wave-functions. The result enables one to develop a theory of paramagnetic absorption of radiofrequency waves by F-centres. As examples, the shape and width of the absorption bands in KCl and NaCl crystals were obtained. A.

539.2

2037. OPTICAL PROPERTIES OF F$^-$-CENTRES. V.L.Vinetskiĭ.
Zh. éksper. teor. Fiz., Vol. 33, No. 3(9), 780-7 (1957). In Russian.

The quantum states are considered for a system consisting of a crystal with two vacancies located at a distance of half a lattice period from each other and of an electron which interacts with the optical crystal vibrations and is localized near this pair of vacancies (a crystal with an F$^-$-centre). The problem is solved in the macroscopic approximation. The parameters of the ground self-consistent states of the system are computed. The frequencies and coefficients for absorption of light are calculated in the Franck–Condon approximation for photo-transitions to the lowest excited states. The azimuthal dependence of the degree of luminescence polarization due to irradiation with polarized light in the F$^-$-absorption bands is also computed; this dependence may be used to identify the F$^-$-centres. The calculations are carried out numerically for KCl crystals. A.

STRUCTURE OF SOLIDS

539.213

2038. STRUCTURE OF SODIUM METAPHOSPHATE GLASS. G.W.Brady.
J. chem. Phys., Vol. 28, No. 1, 48-50 (Jan., 1958).

The X-ray diffraction pattern of sodium metaphosphate glass (formula $NaPO_3$) was determined. The radial distribution function determined from the diffraction pattern indicates that the structure consists of long chains of PO_4 tetrahedra crosslinked to other chains by O–Na–O– bonds. This model agrees with the one advanced by other workers who applied high-polymer techniques to the study of metaphosphates. A.

539.215.4

2039. THE PARTICLE SIZE OF SOME WITWATERSRAND MINE DUST. H.St G.Tucker.
Brit. J. appl. Phys., Vol. 9, No. 3, 98-102 (March, 1958).

The size distribution of mine drilling dust is examined and the use of Gaudin's relation to describe it proposed. The literature is reviewed and it is inferred that this is the true distribution for any dust of this kind. A.

539.219

2040. CORRELATION IN SOLID SOLUTIONS. I.M.Lifshits and G.I.Stepanova.
Zh. éksper. teor. Fiz., Vol. 33, No. 2(8), 485-94 (1957). In Russian.

A method for describing the non-equilibrium states of solid solutions is proposed which is based on prescription of a system of correlation functions for the dissolved atoms. A method is developed for determination of the free energy of solid solutions in states of partial or total equilibrium. In the general case the free energy is expressed in terms of double, triple etc. "interactions" between the admixture atoms which are assumed to be known. For isotope mixtures the "vibrational interaction" energy can be determined in a closed form and the problem can be calculated completely. With the aid of the expressions obtained, correlation functions for dissolved atoms are determined. The effect of correlation on scattering of neutrons by isotope solutions is ascertained. A.

539.234 : 535.555

DOUBLE REFRACTION BY FLUORIDE LAYERS. See Abstr. 1637

ELASTICITY. STRENGTH. RHEOLOGY

539.374

2041. UNLOADING EFFECTS IN THE PLASTIC PROPERTIES OF COPPER SINGLE CRYSTALS. M.J.Makin.
Phil. Mag. (Eighth Ser.), Vol. 3, 287-301 (March, 1958).

Yield-point phenomena occur on retesting copper single crystals during interrupted tensile deformation. The effect is observed only during the linear and parabolic regions of the stress–strain curve and the size of the yield drop is directly proportional to the reduction in stress on unloading. The ratio of the flow stress immediately before complete unloading to that on retesting is 0.986, and appears to be independent of temperature between −195°C and 100°C. The magnitude of the yield phenomenon at −195°C is markedly increased, however, by annealing at above −170°C, and this effect is independent of the amount of unloading. An explanation of these phenomena is advanced in which Lomer–Cottrell sessile dislocations are formed during unloading, and that it is these dislocations which prevent large scale reverse plasticity. The increased effect at −195°C on annealing is interpreted in terms of the thermally activated reversal of the apices of these sessile dislocations. A.

539.4.011.23

2042. A THEORY OF DELAYED YIELDING IN THE PRESENCE OF COTTRELL ATMOSPHERES OF SOLUTE ATOMS. N.Louat.
Proc. Phys. Soc., Vol. 71, Pt 3, 444-56 (March, 1958).

A theory of yielding in iron is developed which includes the effect of the continued reduction with time under load of the restraint offered to the motion of dislocations by atmospheres of solute atoms. The manner in which this reduction comes about, namely by decrease in atmosphere density consequent on the bending of the dislocations, is analysed and is shown to lead to the existence of stress and temperature-dependent delay times and to the presence of microstrain prior to yielding. Qualitative and to some extent quantitative agreements is found between the predictions of the theory and the experimental evidence. A.

539.58

2043. NEW METHOD FOR MEASURING LINEAR COMPRESSIBILITY OF SOLIDS. J.Reitzel, I.Simon and J.A.Walker.
Rev. sci. Instrum., Vol. 28, No. 10, 828-9 (Oct., 1957).

An apparatus is described for measuring linear compressibility of rods and tubes under hydrostatic pressures to 4000 kg/cm^2 and temperatures to 260°C. The measurements are made by means of a linear-differential transformer located on the outside of the non-magnetic high-pressure container. The differential transformer makes it possible to determine the position of a small iron cylinder affixed to the sample. Compressibility of vitreous silica determined by this method was obtained as $-\Delta V/V = p(26.43-0.0049t) \times 10^{-7} + p^2(21.8-0.040t) \times 10^{-12}$; compressibility is expressed in relative volume change, p in kg/cm^2 and t in deg C. A.

539.67

2044. A VACUUM VISCOMETER FOR METAL WIRES. C.Sălceanu.
C.R. Acad. Sci. (Paris), Vol. 245, No. 18, 1505-6 (Oct. 28, 1957). In French.

In the derivation of the relation for the viscosity η given in Abstr. 3328 (1956) air resistance was not considered. An apparatus

to determine the influence of the air resistance as a function of the frequency of torsional vibrations of the pendulum is very briefly described. The results for five frequencies between 1 and 5 vib/sec using a platinum wire under constant tension and in a vacuum of about 0.1 mm Hg are tabulated. The ratio η_{air}/η_{vacuum} increases with the frequency ν and $(\nu\eta_{vacuum})$ is constant. S.Weintroub

PHYSICAL CHEMISTRY

PHASE EQUILIBRIUM. CHEMICAL REACTIONS

541.124

2045. ON THE PROBLEM OF ENERGY TRANSPORT IN CHEMICALLY REACTING PLASMA. H.J.Kaeppeler.
Z. Phys., Vol. 148, No. 4, 425-34 (1957). In German.

Analytical integration of the expression for the contribution of the energy of reaction to the total energy transport is found to be possible in certain simplified cases. The disturbance to thermal equilibrium of exothermicity of the reaction is briefly discussed and attention drawn to non-isothermal plasma. The possibility of approximate (practical) calculation of temperature profiles and of heat transfer in chemically reacting plasma is suggested.

W.Good

541.126 : 541.57

2046. HYDROGEN BONDING IN RADICAL REACTIONS. SOME REMARKS ON CF_3 RADICALS. M.Szwarc and J.Smid.
J. chem. Phys., Vol. 27, No. 2, 421-2 (Aug., 1957).

Studies of the decomposition of acetyl or propionyl peroxide on the one hand and benzoyl peroxide on the other seem to demonstrate that Ph·COO radicals form hydrogen bonds with carboxylic acids, while the nonpolar alkyl radicals do not form such bonds. The formation of hydrogen bonds facilitates the hydrogen transfer between the carboxylic acid and the polar radicals. A.

541.127

2047. KINETICS OF GAS PHASE HALOGENATION REACTIONS. S.W.Benson and J.H.Buss.
J. chem. Phys., Vol. 28, No. 2, 301-9 (Feb., 1958).

Making use of the independently measured rate constants for tee reactions; $X + X + M \rightleftharpoons X_2 + M$ (where X = Br, I, etc.) it is possible to calculate the times needed to approach the stationary state for X atoms. On applying these results to the kinetic studies which have been made of halogenation reactions, it is found that for most thermal brominations, the times are in excess of 100 seconds. For thermal chlorinations, the times are in excess of 1000 seconds while for more strongly bonded diatomic molecules they are still higher. In photochemical systems the times are of the order of 0.1 to 1.0 second for absorbed intensities of 10^{12} quanta/cm^3.sec which are quite usual. The implications of these values for many of the systems studied, are that heterogeneous initiation and termination of chains are contributing significantly to the kinetics of thermal halogenations at temperatures below 500°C. An examination of the brominations of isobutane, toluene, and neopentane shows that the mechanisms proposed in each case may be suspect and that heterogeneities are of likely importance and may account for the anomalous rate constants reported for these systems. Methods are employed for estimating to ±2 cal/mole.deg K the entropies of free radicals and molecules. The entropy of t-butyl bromide is estimated to be 86.6 e.u. at 400°K while neopentyl bromide is 105.3 e.u. at 470°K. These entropy estimates make possible an examination of the self-consistency of the rate data with the proposed rate laws. It is shown that for the systems mentioned above, the data lead to the conclusion that other termination processes must be important, in contradiction to the empirically observed rate laws. Finally, arguments are presented to show that bimolecular Arrhenius frequency factors should be less than collision frequencies. A.

541.127

2048. THEORETICAL TREATMENT OF THE KINETICS OF DIFFUSION-LIMITED REACTIONS. T.R.Waite.
Phys. Rev., Vol. 107, No. 2, 463-70 (July 15, 1957).

The problem of the kinetics of the diffusion-limited reaction $A + B \rightarrow AB$ is formulated in terms of the pair probability densities of the reacting particles (every A taken with every B). The alteration of these pair densities due to diffusion and reaction is considered. The competition of every A for every B and the removal of particles from the system upon reaction are appropriately accounted for. The formulation leads to a set of coupled differential equations that can be solved for a variety of boundary conditions. The problem is solved in detail for a random initial distribution. The rate of reaction at any time is just the probable rate at which a single A and a single B diffuse together (with an appropriate boundary condition for reaction on close approach) multiplied by the product of the number of A's and the number of B's present at that particular time. The rate of the reaction $A + B \rightarrow AB$ will be second order and the reaction $A + B \rightarrow B$ will be first order after times long compared to a transient whose form is given explicitly). More general equations are obtained to permit the treatment of non-random initial distributions, as occur, for example, in the annealing of radiation damage. In such cases the irregular transients may account for a major portion of the reaction. A.

541.127

2049. GENERAL THEORY OF BIMOLECULAR REACTION RATES IN SOLIDS AND LIQUIDS. T.R.Waite.
J. chem. Phys., Vol. 28, No. 1, 103-6 (Jan., 1958).

An argument is presented to show that the theory of kinetics of diffusion limited reactions developed in the preceding abstract may be generalized to a theory of bimolecular reaction rates in condensed phases. The rate at which particles arrive at a separation suitable for reaction is given by differential equations describing the random walks of the particles. The probability of reaction of particles separated by this collision diameter (i.e.,near neighbours in the condensed system) is given by a steric and activation energy factor. The resulting boundary value problem is solved in detail. Explicit expressions for the reaction rates are presented. The reaction follows second-order kinetics except that the most general rate "constant" is time dependent. Reaction rates are discussed in terms of the diffusion parameters and forces between the reactant particles. Physical interpretations of the rate constant are suggested. Reaction rates in liquid solvents are related to the viscosity of the solvent phase. An effective capture radius is derived for particles with long-range forces. A.

ELECTROCHEMISTRY

541.133

2050. IONIC CONDUCTIVITY OF POTASSIUM AND RUBIDIUM CHLORIDE SOLUTIONS AT MICROWAVE FREQUENCIES. T.H.E.Bryant and E.H.Grant.
Proc. Phys. Soc., Vol. 71, Pt 1, 134-5 (Jan., 1958).

The ionic conductivities of 0.05 N solutions of KCl and RbCl were determined at a wavelength of 16.7 cm, using the coaxial line phase and amplitude balance method (Abstr. 2701/1955). The results are compared with those of Little and Smith on aqueous solutions of NaCl and KCl at 10 cm (Abstr. 3219/1955). Little and Smith interpreted their results to find 27 water molecules in the third shell surrounding the ion: the present work yields the value 22 ± 4.

A.J.Mee

541.133 : 538.27

2051. ELECTRON RESONANCE IN SOLUTIONS DURING CURRENT FLOW. A.A.Galkin, Ya.L.Shamfarov and A.V.Stefanishina.
Zh. éksper. teor. Fiz., Vol. 32, No. 6, 1581-2 (1957). In Russian.

Electron resonance was observed in a solution of NaCl in NH_3 at 9000 Mc/s during the passage of a current. The line coincided with that for Na in NH_3 indicating electron-type conduction. The resonance was observable at liquid-nitrogen temperature even in the absence of a current. J.B.Arthur

541.134

2052. REVERSIBLE CHLORINE ELECTRODE FOR THE MEASUREMENT OF ELECTROMOTIVE FORCE IN MOLTEN SALT CELLS. S.Senderoff and G.W.Mellors.
Rev. sci. Instrum., Vol. 29, No. 2, 151-2 (Feb., 1958).

A reversible chlorine electrode which may be used in molten

salts up to temperatures of at least 900°C is described. Chlorine gas is forced through a porous graphite cylinder in contact with the solution under study. The electrode was tested in the $Ag|AgCl|Cl_2$ (graphite) cell and an exactly linear dependence of e.m.f. on temperature was found for the temperature range 530 to 920°C. Excellent agreement with earlier e.m.f. measurements at temperatures below 600°C was found and the results indicate that the calculated values based on thermal data at high temperatures are high. Values of e.m.f. for the cell from 530 to 920°C are given. A.

541.135

2053. IONIC CONDUCTION AT HIGH ELECTRIC FIELD STRENGTHS IN TANTALUM PENTOXIDE.
A.R.Bray, P.W.M.Jacobs and L.Young.
Proc. Phys. Soc., Vol. 71, Pt 3, 405-15 (March, 1958).

Polarization of the cell $|Ta|Ta_2O_5|$solution$|Pt$ sets up a very high electric field strength in the oxide and ionic conduction (resulting in growth of the oxide film) occurs with negligible electronic conduction. Measurements of field strength and current density were made in this cell in the temperature range −63 to +90°C. The results are incompatible with single-barrier control in which space charge is neglected but are consistent with a theory proposed by Dewald (J. Electrochem. Soc., Vol. 102, 1, 1955) in which space charge due to ions in transit causes the field in the oxide to vary through its thickness, so that barriers near the metal interface and within the oxide both play a part in controlling the rate of oxide formation. A.

PHOTOCHEMISTRY. RADIATION CHEMISTRY

541.14

2054. REACTION OF DIBORANE WITH Hg $6(^3P_1)$ ATOMS.
T.Hirata and H.E.Gunning.
J. chem. Phys., Vol. 27, No. 2, 477-80 (Aug., 1957).

An investigation was made of the decomposition of diborane, photosensitized by mercury-$6(^3P_1)$ atoms under static conditions, at 29.30°C. The quantum yields of pressure increase and product formation were found to be independent of substrate pressure in the complete quenching region. For runs of one hour duration at an incident light intensity of 2.5×10^{-6} einstein/min, the quantum yields are 0.50 ± 0.02 for hydrogen, 0.25 ± 0.02 for tetraborane, 0.02 ± 0.02 pentaborane and 0.070 ± 0.002 for pressure increase. The mean quantum yields of hydrogen and tetraborane formation were found to decrease with increasing duration of exposure during the first half-hour of irradiation. Constant values were reached after 30-45 min of exposure. The ratio of the rates of hydrogen to tetraborane formation was found to maintain a value of two, independent of substrate pressure and duration of exposure, for runs exceeding five minutes in duration. Extensive decomposition was found to lead to solid products. A mechanism is proposed involving the primary scission of the B–H bond which accounts qualitatively for the observed characteristics of the reaction. The resemblance between ethane and diborane with respect to their behaviour toward Hg $6(^3P_1)$ atoms is pointed out. A.

541.15

2055. DECOMPOSITION OF NITRIC OXIDE AND NITROGEN DIOXIDE BY THE IMPACT OF FISSION FRAGMENTS OF URANIUM-235. P.Harteck and S.Dondes.
J. chem. Phys., Vol. 27, No. 2, 546-51 (Aug., 1957).

A study was made of the decomposition of nitric oxide and nitrogen dioxide using the fission recoil energy of 5 mg of uranium-235 oxide powder. The irradiations were conducted in a 23 cm^3 quartz vessel, at a flux of 3×10^{12} neutrons/cm^2.sec, and at a temperature of 70°C in the Brookhaven National Laboratory Reactor. With a dose of 2×10^9 r, the over-all G_{NO} is 9.5 ± 1.0, using a radiation intensity of 1.0×10^7 r/min, a filling pressure of 500 mm at 21°C. With a dose of 10^8 r, the G_{NO} is 13.8 ± 1.4. Since three additional nitric oxide molecules are consumed for each nitric oxide molecule decomposed at 10^8 r, the G_{NO} value calculated for the primary decomposition (including the dissociation due to ion-recombination) is 3.45 ± 0.35. The G_{NO_2} value is 1.2 for a dose of 3×10^9 r and 0.5 for 5×10^7 r, conducted under a radiation intensity of 1.2×10^7 r/min and a filling pressure of 550 mm of the 2 $NO_2 \rightleftharpoons N_2O_4$ equilibrium at 21°C. For the principal reactions in the nitric oxide and nitrogen dioxide systems, when irradiated with ionizing radiation, a reaction mechanism is proposed which seems to explain the characteristic features of the system. A.

DISPERSIONS. COLLOIDS. ADSORPTION

541.183

2056. EFFECT OF ADSORBENT PERTURBATION ON B.E.T. THEORY. W.L.Peticolas.
J. chem. Phys., Vol. 27, No. 2, 436-8 (Aug., 1957).

The statistical mechanical derivation of the B.E.T. equation is extended to include perturbations of the adsorbent by the adsorbate. The thermodynamic functions are recalculated to include this effect. The thermodynamic functions for the adsorbent as well as the adsorbate are calculated. A.

541.183.26 : 537.331.33

OXYGEN SORPTION PHENOMENA ON CADMIUM SELENIDE CRYSTALS. See Abstr. 1686

541.183.5

2057. ADSORPTION OF NICKEL ON MOLYBDENUM IN THE FIELD EMISSION MICROSCOPE. E.C.McIrvine and R.C.Bradley.
J. chem. Phys., Vol. 27, No. 3, 646-52 (Sept., 1957).

An investigation of the adsorption of nickel on molybdenum is compared with theoretical considerations of adsorption phenomena. Nickel was found to adsorb coherently on molybdenum, preferentially on the (111) planes of the substrate. For coverages of about $\frac{1}{5}$ of a monolayer, the following activation energies were determined:

Q_d = (2.10 ± 0.05) eV (desorption)
Q_m = (1.31 ± 0.08) eV (surface migration $\frac{1}{4}$ completed)
Q_m = (1.42 ± 0.05) eV (surface migration $\frac{1}{2}$ completed)
Q_m = (1.48 ± 0.06) eV (surface migration $\frac{3}{4}$ completed).

The desorption energy did not vary with degree of completion. Heavy adsorbed layers of nickel were investigated. The equilibrium position of heavy layers was found to be field dependent. A.

CRYSTALLOGRAPHY

548.5

2058. THE SYNTHESIS OF SINGLE CRYSTALS OF THE SULPHIDES OF ZINC, CADMIUM AND MERCURY AND OF MERCURIC SELENIDE BY VAPOUR PHASE METHODS.
D.R.Hamilton.
Brit. J. appl. Phys., Vol. 9, No. 3, 103-5 (March, 1958).

Experiments with the Reynolds–Czyzack method of growth are described for zinc sulphide and cadmium sulphide. A new application of the method to the crystallization of mercuric sulphide is discussed. Single crystals of mercuric selenide have been produced by a vapour-phase reaction and similar experiments attempted with mercuric telluride. The conditions of growth are examined in the light of recent theory; estimates of surface free energies are obtained. A.

548.574

2059. HILLOCKS, PITS, AND ETCH RATE IN GERMANIUM CRYSTALS. B.W.Batterman.
J. appl. Phys., Vol. 28, No. 11, 1236-41 (Nov., 1957).

Symmetric, faceted etch hillocks were observed on certain germanium surface orientations exposed to an H_2O_2–HF (Superoxol) etchant. Considerations of surface curvature and etch rate lead to the conclusion that the faces bounding the hillocks must be at saddle points on an etch rate v. orientation surface. A measurement of etch rate throughout the stereographic triangle supported this conclusion. The formation of dislocation pits and hillocks is discussed in terms of the variation of surface etch rate with orientation. A.

X-RAY CRYSTALLOGRAPHY

548.73/.74

X-RAY AND ELECTRON INVESTIGATION OF MATERIALS. See also under "Structure of solids". Decimal classification 539.26/.27

548.733

2060. POINT-FOCUSING TWO-CRYSTAL X-RAY MONOCHROMATOR FOR X-RAY DIFFRACTION. T.C.Furnas, Jr.
Rev. sci. Instrum., Vol. 28, No. 12, 1042-8 (Dec., 1957).

Crystal monochromators can provide the exceptionally fine collimation requisite for the study of small-angle diffraction phenomena. To obtain sufficient intensity and contrast it is necessary not only to bend the crystal but also to use two crystals in tandem with their focal circles mutually orthogonal. The apparatus described uses the X-ray "weak window" line source to illuminate the (200) planes of mica in transmission and the (10$\bar{1}$1) planes of a cylindrically ground polished, and etched quartz crystal in reflection. Symmetrical couple mounts were used to minimize aberrations. The camera essentially isolates the $K\alpha_1$ component and consequently reduces diffuse background and general radiation artifacts as shown by pertinent applications to collagen and feather keratin. Although operating in air and using exposure times comparable (50-250 hr) to those encountered with aperture-collimated systems, the camera has resolved the central first order of the 640 A macroperiod of collagen fibres and is capable of resolving consecutive orders of spacings as high as ~ 3800 A. The Johannsson, Johann, and Cauchois geometries are illustrated in a new manner to show the importance of weak and large sources of X-rays, to demonstrate the focal pattern characteristic of two-crystal point-focusing arrangements, and to show why mosaic crystals are incapable of the fine focus required. A.

548.735

2061. DIRECT STRUCTURE DETERMINATION BY OPTICAL-TRANSFORM METHODS.
M.M.Crowder, K.A.Morley and C.A.Taylor.
Nature (London), Vol. 180, 431-2 (Aug. 31, 1957).

The structure on which this method was tested had four molecules of $C_7O_3NH_7$ in the unit cell; steps by which its structure was determined are given. A.R.Stokes

GEOPHYSICS

550.38 : 538.711

2062. AN ELECTRICAL RECORDING MAGNETOMETER.
P.H.Serson.
Canad. J. Phys., Vol. 35, No. 12, 1387-94 (Dec., 1957).

An instrument for recording at a fixed station variations in three orthogonal components of the earth's magnetic field is described. The sensitive head, containing detectors of the saturated transformer type, can be operated out of doors at the end of a long cable. A strip-chart recording meter provides a visible record of the three d.c. output signals (1 volt = 100 gammas). Calibrated baseline controls permit biasing of the magnetic detectors for any location in Canada. Tests on 10 instruments indicate a noise level of 3 gammas and a maximum drift of 10 gammas in 10 hours. A.

550.38 : 538.245

CHEMICAL MAGNETIZATION OF ROCKS. See Abstr. 1780

551.43

2063. ON A NEW THEORY OF MOUNTAIN BUILDING.
A.E.Scheidegger.
Canad. J. Phys., Vol. 35, No. 12, 1380-6 (Dec., 1957).

In recent years there has been a growing body of evidence indicating that continental drift might have occurred on a large scale. Without prejudicing the reality of such drift (which must be decided upon from factual evidence), this paper investigates the forces that might possibly have caused it. This leads to a new theory of mountain building. It is shown that continental drifting, as it is indicated by presently available evidence, might be explained by the assumption of a random drag force with a correlation time of 150 million years. It is possible, though not altogether likely, that this drag force might be the result of very large (radius 6000 km) random convection currents. Their duration would also have to be of the order of 150 million years. The assumption of a random drag force does not necessarily contradict ideas maintaining that continental growth also took place; the two effects might well be superimposed upon each other. A.

ATMOSPHERE. METEOROLOGY

551.508.5

2064. TEMPERATURE AND PRESSURE CORRECTIONS TO BE APPLIED TO THE SHIELDED HOT WIRE ANEMOMETER AT SPEEDS FOR WHICH NATURAL CONVECTIVE COOLING IS NEGLIGIBLE. C.F.Cowdrey.
Brit. J. appl. Phys., Vol. 9, No. 3, 112-16 (March, 1958).

The form of the law of cooling of a shielded hot-wire anemometer should not differ greatly from the normal laws of cooling of heated cylinders. By using the law propounded by Hilpert, a method is devised to allow for changes in ambient temperature and pressure when a hot wire anemometer is used at speeds for which the cooling can be considered as entirely due to forced convection. This method is then used to derive the corrections needed in the measurement of air flow over the range of variation of atmospheric conditions normally experienced. However, with slight modifications to allow for changes in the values of the physical constants, it should be possible to use the general method to cover all "perfect" gases at various ambient conditions. A number of experimental results are included in support of the theory. A simple circuit is indicated in the appendix, based on that outlined by Simmons (Abstr. 1576/1950), by which the useful range of the instrument is greatly increased. A.

551.510.535

2065. AN EASILY APPLIED METHOD FOR THE REDUCTION OF h—f RECORDS TO N—h PROFILES INCLUDING THE EFFECTS OF THE EARTH'S MAGNETIC FIELD. E.R.Schmerling.
J. atmos. terrest. Phys., Vol. 12, No. 1, 8-16 (1958).

A method is presented by means of which experimental h'—f records may be readily reduced to electron-density/height profiles without the use of computing aids during the final reduction process. No special assumptions are made concerning profile shapes, account is taken of the earth's magnetic field, and collisions are neglected. This method depends on sampling h' at fixed sub-multiples of the frequencies f_n at which true heights are required: true heights being then simply obtained by averaging these values. The sampling frequencies depend on the parameters of the earth's magnetic field, and must be computed for the magnetic coordinates of each station from which records are to be analysed. This computation, in its entirety, is quite complex; but once performed, the results are available for use on any number of records. The method is, therefore, especially suitable for the rapid routine reduction of large numbers of records. Complete computations are presented for one station, and the results are checked against an analysis of h'—f curves for known profiles. A.

551.510.535

2066. A STUDY OF THE IONOSPHERIC IRREGULARITIES WHICH CAUSE SPREAD-F ECHOES AND SCINTILLATIONS OF RADIO STARS. B.H.Briggs.
J. atmos. terrest. Phys., Vol. 12, No. 1, 34-45 (1958).

A study is made of the correlation between the occurrence of spread-F echoes at Slough, Inverness and Oslo. It is concluded that the ionospheric irregularities which cause the spreading occur in patches which have dimensions of the order of 500 km in a N—S direction, and considerably greater in the E—W direction. There is an indication that these "bands" of irregularities may lie along lines of magnetic lattitude, and that they tend to occur in the same geographical position on successive nights. The correlation of the scintillations of the radio-star in Cassiopeia with the occurrence of spread-F echoes at two places is investigated. The results are found to be consistent with the same picture of the spatial distribution of the irregularities. Some indirect arguments suggest that the irregularities causing the scintillations are at heights near 300 km. A.

551.510.535

2067. THE ELECTRON DISTRIBUTION IN THE IONOSPHERE OVER SLOUGH. I. QUIET DAYS.
J.O.Thomas, J.Haselgrove and A.Robbins.
J. atmos. terrest. Phys., Vol. 12, No. 1, 46-56 (1958).

A method of calculating the distribution of electron density with height from experimental virtual height—frequency records using an electronic digital computer is outlined. The method assumes that the N(h) curve is monotonically increasing but makes no other a priori assumptions about the shape of the layer. It allows for the effect of the earth's magnetic field. The method has been applied to a representative selection of h'(f) records taken at Slough and the F2-layer results for the International Quiet Days are presented and compared with previous work. The height of maximum electron density in the F2-layer is found to be considerably lower than previously supposed, particularly in the summer and equinox months. Results for the F1-layer show that the peak of the layer (h_mF1) is lower than previously supposed and that the seasonal variation of h_mF1 is the opposite to that expected for a Chapman layer. A.

551.510.535 : 523.78

2068. IONOSPHERIC RECORDS OF SOLAR ECLIPSES.
G.H.Munro and L.H.Heisler.
J. atmos. terrest. Phys., Vol. 12, No. 1, 57-67 (1958).

Interpretations of radio observations of solar eclipses are reviewed on the basis of experience gained in the study of travelling ionospheric disturbances. It is shown that the passage of an eclipse introduces horizontal gradients of ionization which distort the ionospheric reflecting surfaces. This implies that ionosonde soundings are no longer truly vertical and their interpretation as such must introduce errors in deduced ion distributions. In addition, the varying obliquity of the returned rays will distort the apparent variation of ion density with time, and focusing may cause inaccuracies in deduced reflection coefficients. It is emphasized that during eclipses incidental travelling disturbances will cause additional complications, which further confuse interpretation, and it is shown how they may be detected on ionosonde records. Confirmation of the presence of curvature is provided by actual records of the 1940 eclipse taken in South Africa by A.J.Higgs (Monthly Not. Roy. Astron. Soc., Vol. 102, 24, 1942). It is found difficult to estimate the actual errors in past observations, and supplementary observations during future eclipses are suggested to facilitate such corrections and make more precise deductions possible. A.

551.510.535

2069. THE HEIGHT VARIATION OF DRIFT IN THE E REGION.
I.L.Jones.
J. atmos. terrest. Phys., Vol. 12, No. 1, 68-76 (1958).

Observations of drift velocities in the E-region of the ionosphere have been made simultaneously with waves of frequency about 2.0 and 2.5 Mc/s, by means of the Mitra method. Since the observed velocities were significantly different, it is deduced that the important scattering occurs near the level of reflection, so that the observations on the two frequencies provide information about the drift velocities at two different heights. The velocities rotated through 360° in the course of the daylight hours, and during the winter months the rotation corresponding to reflection at the smaller height lagged behind that corresponding to the greater. The rotation of the velocity was not uniform during the day, and this non-uniformity is explained by considering how the height of reflection varies during the day. When the results were compared with those deduced from radio observation of meteor trails made by Greenhow and Neufeld (Abstr. 2869/1957), it was found that the time lag between the rotating drifts observed by the two methods could be satisfactorily explained if proper account was taken of the different heights to which the observations refer. Rapid changes in the drifts were observed in September and October by both methods. A.

551.510.535

2070. IONOSPHERIC DRIFT IN THE F2 REGION NEAR THE MAGNETIC EQUATOR. B.W.Purslow.
Nature (London), Vol. 181, 35-6 (Jan. 4, 1958).

Measurements of horizontal drifts in the F2-region at Singapore by the spaced-receiver method indicate that these are predominantly east–west with a 24 hour period, changing from maximum easterly (~ 90 m/sec) at night to westerly (~ 30 m/sec) by day. The north–south component is generally much smaller. These results are in phase opposition to those found for higher latitudes, and may be interpreted as evidence for Martyn's theory of electromagnetic coupling between the E-region (where the dynamo currents flow) and the F-region along the magnetic lines of force. G.M.Brown

551.510.535 : 523.164.4

2071. THE USE OF RADIO STARS TO STUDY IRREGULAR REFRACTION OF RADIO WAVES IN THE IONOSPHERE.
H.G.Booker.
Proc. Inst. Radio Engrs, Vol. 46, No. 1, 298-314 (Jan., 1958).

The observations and the theory of radio-star scintillation are reviewed, and the following conclusions are reached. (1) The frequency variation of amplitude and phase scintillations agrees with theory. (2) All observers agree that there is a marked increase of amplitude scintillation with increase in zenith angle. The Cambridge data agrees with theory, but the Manchester data does not. No available zenith angle data is adequate to determine the height of scintillation. (3) The available observations of phase scintillation are inadequate for almost all purposes. (4) At present, the Hewish method of locating height by comparing amplitude and phase scintillation is seriously hampered by lack of satisfactory observations. On existing data the method gives heights that are spread over a range of about five to one; all of these heights are above the E region and refer to nightime scintillation. (5) All observers agree that there is a maximum of amplitude scintillation in the middle of the night. (6) In addition, Australian observers report a maximum of amplitude scintillation at midday. This is only weakly observed, if at all, in the northern hemisphere, where, however, observational conditions are different. (7) Australian observers report maxima of amplitude scintillation at the solstices and minima at the equinox, but observers in the northern hemisphere report little seasonal variation. (8) The rate of scintillation increases under magnetically disturbed conditions, due to increased drift velocity. (9) There is a good general correlation between the occurrence of radio-star scintillation and spread F reflections. This correlation suggests a value of the order of 250-300 km for the height of radio-star scintillation at night. (10) There is some correlation between the occurrence of radio-star scintillation and sporadic E reflections, expecially in Australia. (11) The physical cause of the fluctuations in electron density associated with radio-star scintillation is uncertain, but there is little doubt that some of the other phenomena involving irregularities of electron density in the ionosphere are due to turbulence. (12) The scale of irregularities of electron density at the level responsible for amplitude scintillations is of the order of a kilometre. The scale is probably somewhat greater parallel to the earth's magnetic field than transverse to the field. (13) The most striking puzzle in connection with radio-star scintillation is the cause of the night-time maximum. A.

551.510.535 : 523.164.4

2072. AN INVESTIGATION OF THE PERTURBATIONS IMPOSED UPON RADIO WAVES PENETRATING THE IONOSPHERE.
R.S.Lawrence.
Proc. Inst. Radio Engrs, Vol. 46, No. 1, 315-20 (Jan., 1958).

A new method has been devised to measure continuously the phase deviations introduced by the ionosphere into the signals from discrete sources. Sample recordings of measurements at frequencies of 53, 108, and 470 Mc/s are given. An experiment combining this phase measuring technique and standard ionospheric soundings at the point of penetration of the line of sight is in progress and is expected to shed light upon the height of origin of ionospheric scintillations. A.

551.510.535 : 523.164

2073. SOME MEASUREMENTS OF HIGH-LATITUDE IONOSPHERIC ABSORPTION USING EXTRATERRESTRIAL RADIO WAVES. C.G.Little and H.Leinbach.
Proc. Inst. Radio Engrs, Vol. 46, No. 1, 334-48 (Jan., 1958).

Describes the manner in which 30 Mc/s extraterrestrial radiowaves have been used to study the radio absorption characteristics of the arctic ionosphere. It opens with a brief discussion of the theory of ionospheric absorption, followed by a description of the basic principles involved in the technique. Two different types of equipment which have been used in these absorption measurements are then discussed and typical records presented. The observations show that the regions of anomalous high-latitude absorption typically have lateral dimensions in excess of 100 km, and that marked differences can occur during disturbed periods between stations 800 km apart. Almost all the absorption of the extraterrestrial radiowaves occurs below the E region. The absorption correlates well with the local geomagnetic K index, and apparently is associated with the bombardment of the upper atmosphere by the corpuscular streams which produce the aurora. The increase of absorption during daylight hours is thought to be due to a decrease in effective height of the absorbing layer, resulting from a photo detachment of electrons at heights of the order of 60-80 km, rather than to an increase in the strength of the corpuscular bombardment. A.

551.510.535 : 523.78 : 523.164.32

IONOSPHERIC EFFECTS OF A SOLAR ECLIPSE. See Abstr. 1432

551.510.535

RADIO-WAVE PROPAGATION IN THE IONOSPHERE. See also under "Electromagnetic waves and oscillations". Decimal classification 538.566.3

551.593.54

2074. WAVELENGTH DEPENDENCE OF THE SCATTERING COEFFICIENT FOR INFRARED RADIATION IN NATURAL HAZE. M.G.Gibbons.
J. Opt. Soc. Amer., Vol. 48, No. 3, 172-6 (March, 1958).

From the best published data, it is shown that to an approximation of ±4% the extinction coefficient for scattering by natural haze, when referred to its value at 0.61 μ varies as $\lambda^{-0.7}$ in the region of wavelength from 0.61 to 11.48 μ regardless of the visual range. It is also shown that the relationship $\sigma = k\lambda^{-0.7}$ for natural haze is consistent with the known range of sizes and indices of refraction of natural haze particles and their scattering area coefficients as given by the Mie theory. The possibility of this relationship holding also in ordinary smog is indicated. A.

551.594.221 : 538.561 : 621.396.821

2075. CLASSIFICATION OF ATMOSPHERIC WAVEFORMS. F.Hepburn.
J. atmos. terrest. Phys., Vol. 12, No. 1, 1-7 (1958).

The desirability and requirements of a systematic classification of atmospheric waveforms (electromagnetic disturbances resulting from the generation and subsequent propagation of radio waves from lightning discharges) are discussed. An observational scheme is suggested and interpreted in terms of known properties of the discharge and propagation mechanisms. This data is reviewed to clarify application of the scheme to individual waveforms. The relationship of the classification to previous inadequate groupings is indicated. A.

551.594.52 : 523.164.8

2076. DETERMINATION OF AURORAL HEIGHT BY RADAR. R.S.Unwin and M.Gadsden.
Nature (London), Vol. 180, 1469-70 (Dec. 28, 1957).

Preliminary results obtained on an auroral radar operating at 55 Mc/s in South Island, New Zealand, indicate an average height of auroral echoes of 110 km. G.M.Brown

BIOLOGY

MEDICAL SCIENCE. HUMAN PHYSIOLOGY

612.84 : 535.89

ELECTRONIC MULTIFLASH GENERATOR FOR EXPERIMENTS IN PSYCHOPHYSIOLOGICAL OPTICS. See Abstr. 1642

612.843.32

2077. COMPARISON OF SCOTOPIC, MESOPIC, AND PHOTOPIC SPECTRAL SENSITIVITY CURVES. J.A.S.Kinney.
J. Opt. Soc. Amer., Vol. 48, No. 3, 185-90 (March, 1958).

Spectral sensitivity curves were established for the ten-degree periphery throughout a range of intensities from absolute scotopic threshold to a level five log units above threshold. Surround conditions included adaptation of the eye both to complete darkness and to the light level under investigation. In addition, foveal curves were established at one level under the same experimental conditions as the peripheral curves. The results show that there is no large shift in the curves toward the longer wavelengths with increasing intensity until a level five log units above threshold has been reached, and that even at this point, the peripheral curve does not approach the spectral sensitivity found in the foveal curve. While the curves retain the predominant scotopic element, that is, sensitivity to the shorter wavelengths remains basically unchanged, sensitivity to the longer wavelengths does increase throughout the entire range of intensities investigated. This is true for both surround conditions; in addition, a slight increase in sensitivity to the long wavelengths and better brightness discrimination are found with the lighted surround. A.

612.844.24

2078. VARIABILITY OF ACCOMMODATION DURING STEADY FIXATION AT VARIOUS LEVELS OF ILLUMINANCE. M.Alpern.
J. Opt. Soc. Amer., Vol. 48, No. 3, 193-7 (March, 1958).

Using the stigmatoscope, the variability of the dioptric power of the eye during steady fixation was measured for four observers over a range of intensities from 2.5 to 3.0 log trolands in one-half logarithmic steps. Two different viewing conditions, (constant and variable size test letters), were studied but no significant difference between them was obtained. There was almost a fourfold decrease in the variability of the settings as the intensity was increased over this range. There was a sharp transition at one troland, suggestive of a discontinuity between scotopic and photopic vision. These changes could be eliminated by cycloplegia of the fixating eye. Essentially the same results were obtained when the refraction of one eye was measured objectively (with a concidence optometer), while the other eye fixated the chart. This latter technique is, however, less valid at the lower intensities because of the tendency to fixate the measuring light of the optometer. The data can be quantitatively described by a theory which postulates that the accommodation is continually fluctuating and that the limits of fluctuation are proportional to threshold $\Delta I/I$. A.

612.85

2079. PROPOSED LABORATORY STANDARD OF NORMAL HEARING. J.F.Corso.
J. Acoust. Soc. Amer., Vol. 30, No. 1, 14-23 (Jan., 1958).

In recent years there has been a growing concern about the adequacy of the present American reference for normal hearing of pure tones. Results of earlier studies indicate that survey data tend to confirm the present zero reference, but data from laboratory studies have provided some basis for the contention that the present reference is too high. The purpose of the present study was to provide more definitive data on the threshold of hearing for pure tones through an extended laboratory investigation. Audiometric measurements were made on three groups of subjects ranging in age from 18 to 24 years inclusive. All subjects were otologically normal and showed a life history of minimal exposure to high intensity noise. Two groups were tested with ANB-H1A earphones and a 5 dB step-testing procedure in the method of limits; the other group was tested with Permoflux PDR-8 earphones and a 2 dB step-testing procedure. The results of the study indicate significant differences between the groups tested with the two types of earphones, as well as between male and female subjects. In general, excellent agreement was found with other laboratory studies. The threshold curves of the present study expressed in terms of coupler pressures are offered for consideration as a proposed laboratory standard for normal hearing. A.

612.85

2080. FURTHER EFFECTS PRODUCED BY TWO LOUDSPEAKERS IN ECHO-FREE CONDITIONS. D.M.Leakey.
J. Acoust. Soc. Amer., Vol. 29, No. 8, 966 (Aug., 1957).

Reference is made to a letter by Hanson and Kock (Abstr. 8333/1957). The present writer finds very similar results and extends the observations, using speech as the audio-signals and also wide-band noise as a substitute for speech. The apparent change in the position of the sound source is investigated as the phase of one of a pair of loudspeakers is reversed. In these experiments the noise is passed through various filters, e.g. 500 c/s low-pass and 2 kc/s high-pass; in some cases at higher frequencies it was difficult to tell whether the loudspeakers were in phase or in antiphase. An experiment is described which demonstrated the production of a sound image, apparently inside the head, by the use of loudspeakers. A.B.Wood

612.858.751

2081 AN UNEXPECTED EFFECT IN SOUND LOCALIZATION. D.H.Holding and J.P.Dennis.
Nature (London), Vol. 180, 1471-2 (Dec. 28, 1957).

The wearing of an Army "combat cap" with earflaps is reported to improve a subject's ability to spatially localize 1000 c/s tones from the half-left and half-right directions. H.D.Parbrook

613.6

2082. INSTRUMENTS FOR USE IN OCCUPATIONAL HYGIENE. C.N.Davies.
J. sci. Instrum., Vol. 34, No. 11, 425-35 (Nov., 1957).

The British Occupational Hygiene Society held a Conference on this subject in London on 16 and 17 April, 1957. Eight papers were read and are reported in this article. The subject-matter included the planning of sampling programmes for maintaining a healthy working environment in industry and the assessment of incompletely defined atmospheric pollution from observations on human subjects. Instrumentation for safety in mining was described with special reference to gas and dust explosions, pneumoconiosis and non-destructive testing. Details were given of the technical precautions needed when taking chest X-rays for the clinical assessment of pneumoconiosis. The assessment of samples of toxic vapours, secured with a simple hand-pump, was covered in a paper which surveyed recent improvements in absorption methods; the more complex apparatus required for absorption spectrophotometry over a wide range of wavelengths was also reviewed. Safety in the presence of atomic radiations was considered in two papers, one dealing with instruments for measuring and monitoring radiation and the other with instruments used to aid clinical diagnosis of the consequences of human exposure. A.

616.073

2083. EARLY CANCER DIAGNOSIS THROUGH ULTRASONICS. Y.Kikuchi, R.Uchida, K.Tanaka and T.Wagai.
J. Acoust. Soc. Amer., Vol. 29, No. 7, 824-33 (July, 1957).

After various fundamental experiments, echoes were successfully obtained from the human intercranial ventricle and brain tumor not only through dura mater during surgical operation, but also through the skull at preoperative and post-operative examination. In these experiments, 1 to 10 Mc/s ultrasound and A-scope indication were used. It is reported that an echo from the ventricle wall pulsates slowly and rhythmically with synchronization to each heartbeat. Furthermore, success was obtained in detecting echoes from various abdominal organs and tumors through the skin, and it was found that echoes, reflected from the bowel, move in correlation to bowel peristalsis. As the echoes are so clearly perceptible, the authors are now engaged in developing "ultrasono-tomography" for a horizontal section of the human head or abdomen by plan-position indication; such a tomography cannot be attained by any penetration method including X-ray. In thoracic examination also, the authors have attained some achievements not only in the ultrasonic diagnosis of breast tumor but also in the detection of fluctuating echoes from the heart, which are considered valuable for studies of heart function. Regarding the lung, special echoes from lung tumors were found and also from pneumonia lungs. Another important finding is the decrease of ultrasonic attenuation in narcotized tissue. This finding will introduce a future possibility in qualitative measurement of the degree of anesthesia. A.

TECHNIQUE. MATERIALS

669

2084. ON THE ULTIMATE CONCENTRATION DISTRIBUTION IN ZONE-MELTING. I.Braun.
Brit. J. appl. Phys., Vol. 8, No. 11, 457-61 (Nov., 1957).

The ultimate concentration distribution is the distribution which is unaffected by further passes. An exact solution is given of this ultimate distribution for any value of the distribution coefficient k, taking into account the end-effect due to the normal freezing in the last zone. Graphs of the ultimate distribution are given for different values of k and the zone-length. To know how many passes are needed to reach the ultimate distribution, these graphs have been compared with the graphs of the successive concentration profiles. After a certain number of passes the concentration profiles oscillate around the ultimate distribution. These oscillations become smaller and smaller with increasing number of passes. There exists therefore an optimum number of passes with the lowest concentration profile. A.

669.054

2085. THE ULTIMATE DISTRIBUTION OF IMPURITY IN THE ZONE-MELTING PROCESS. L.W.Davies.
Phil. Mag. (Eighth Ser.), Vol. 3, 159-62 (Feb., 1958).

An analytical solution of Pfann's integral equation, for the ultimate distribution of an impurity along a bar, is derived by considering the boundary conditions impressed upon the system by the "normal freezing" of the final zone. The solution will hold for all values of the distribution coefficient and is independent of the bar length. A specimen graph is presented. A.W.Penn

669.054

2086. ELECTROMAGNETIC STIRRING IN ZONE REFINING. I.Braun, F.C.Frank, S.Marshall and G.Meyrick.
Phil. Mag. (Eighth Ser.), Vol. 3, 208-9 (Feb., 1958).

An apparatus employing a rotating magnetic field is described for dispersal of the boundary layer. Recrystallization times of the refined aluminium are used to show that an increase in the efficiency of segregation of impurities occurs. A.W.Penn

PHOTOGRAPHY

771.534

2087. PHOTOGRAPHIC SENSITIVITY. J.W.Mitchell.
Rep. Progr. Phys., Vol. 20, 433-515 (1957).

This paper reviews the experimental and theoretical work on photographic sensitivity and related topics which has been published during the past ten years. New experimental results, obtained to a large extent with model systems, have necessitated substantial revision and amplification of previously accepted theories. The role of crystal imperfections in all aspects of photographic sensitivity is now recognized and emphasis has shifted from the trapping of electrons, which characterized the Gurney—Mott theory, to the trapping of positive holes. The latent image consists of small groups of silver atoms formed by the combination of silver ions and electrons. This proceeds through intermediate stages in which first latent pre-image and then latent sub-image specks appear. The initiation of development by latent image specks of different sizes is discussed in the final sections. The approach which is followed in this paper leads to an integrated treatment of the whole range of photographic phenomena in which very few hypotheses with no direct experimental foundation have to be introduced. A.

778.37 : 778.5

2088. A REVIEW OF THE METHODS OF HIGH-SPEED PHOTOGRAPHY. J.S.Courtney-Pratt.
Rep. Progr. Phys., Vol. 20, 379-432 (1957).

Methods permitting single photographs of 10^{-2} to 10^{-9} sec duration or a series at rates of 10^4 to 10^9 frames/sec are discussed. There are 130 references. E.R.Wooding

778.6 : 535.6.08

INSTRUMENT FOR SELECTING VISUALLY NEUTRAL PHOTOGRAPHIC DYE IMAGES. See Abstr. 1638

LIST OF JOURNALS

The following list supplements the List of Journals published with the June number of Volume 60 (1957) and the Supplement published with the Index to the same volume. Reprints of the List of Journals and of the Supplement can be obtained from The Institution of Electrical Engineers, Savoy Place, London, W.C.2, price 2s.0d. post free.

The addresses given are believed to be correct at the date of publication, but no responsibility can be accepted for errors.

Ingeniøren C
Ingeniøren, Edition C: International Edition. — Dansk Ingeniørforening, 31 Vester Farimagsgade, Copenhagen V. Published quarterly, in English, to bring selected original papers of interest to an international circle of readers.

Kodaikanal Obs. Bull.
Kodaikanal Observatory Bulletin. — India Meteorological Department, Government of India. Publication Office: Astrophysical Observatory, Kodaikanal, India.

Mem. Fac. Engng Kumamoto Univ.
Memoirs of the Faculty of Engineering, Kumamoto University. — Kumamoto, Japan.

Radio Mentor
Radio Mentor. — Hubertusbader Str. 16, Berlin-Grunewald.

Suppl. Progr. theor. Phys.
Supplement of the Progress of Theoretical Physics. — Research Institute for Fundamental Physics, The Physical Society of Japan. Publication Office: Yukawa Hall, Kyoto University, Kyoto, Japan.

Tekn.-vetensk. Forskn. (TVF)
TVF. Teknisk-Vetenskaplig Forskning. — Formerly: IVA. Tidskrift for Teknisk-Vetenskaplig Forskning [I.V.A. (Stockholm)]. IngeniörsVetenskapsAkademien [The Royal Swedish Academy of Engineering Sciences], Grevturegatan 14, Stockholm 5.

NOTES

I.V.A. (Stockholm)
IVA. Tidskrift for Teknisk-Vetenskaplig Forskning. — Title changed to: TVF. Teknisk-Vetenskaplig Forskning [Tekn.-vetensk. Forskn. (TVF)] starting with Vol. 29, No. 1, 1958.

Nuclear Sci. Engng
Nuclear Science and Engineering. — Address changed to: 111 Fifth Avenue, New York 3, N.Y.

U.R.S.I. Inform. Bull.
U.R.S.I. Information Bulletin. — Address changed to: 7 Place Emile Danco, Brussels.

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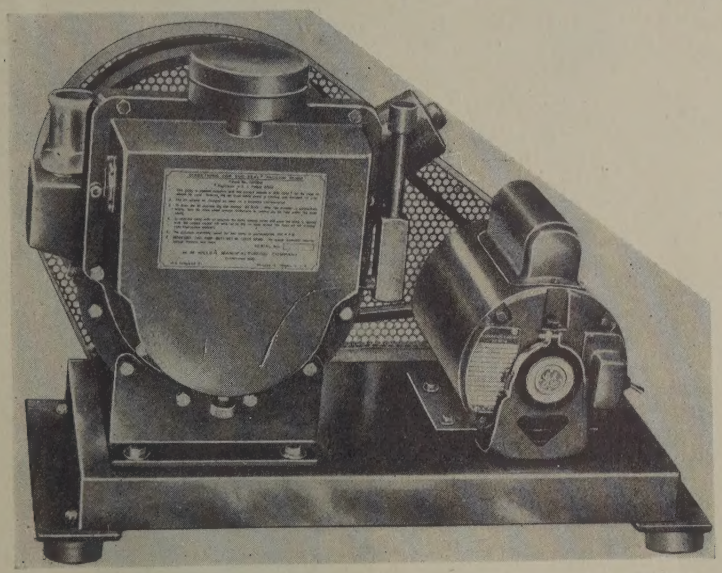

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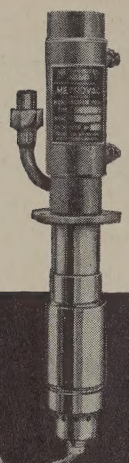

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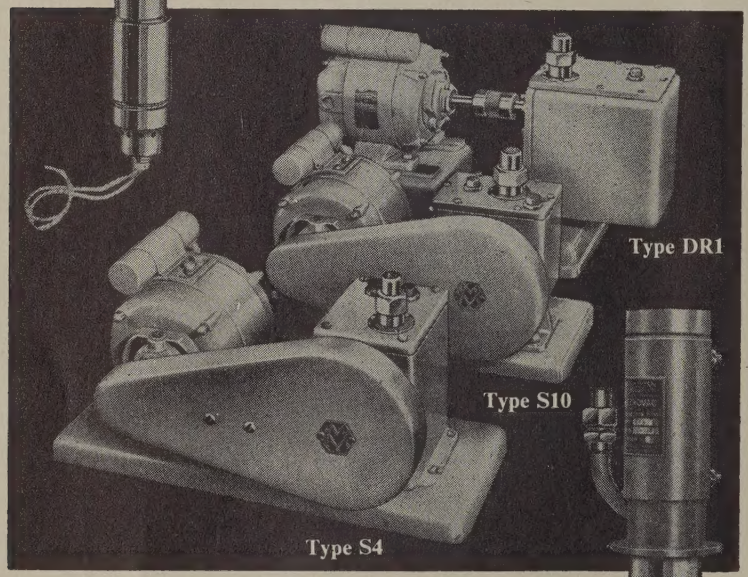

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